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"TORCHWELD"

Torches are an absolute guarantee against hard to machine welds.

They are designed to deliver a perfect mixture of gases to the welding tip. Soft welds are, therefore, easily obtained with the TORCHWELD process.

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Manufacturers of High Grade Welding and Cutting Equipments, Welding Materials, Fluxes, Supplies and Accessories

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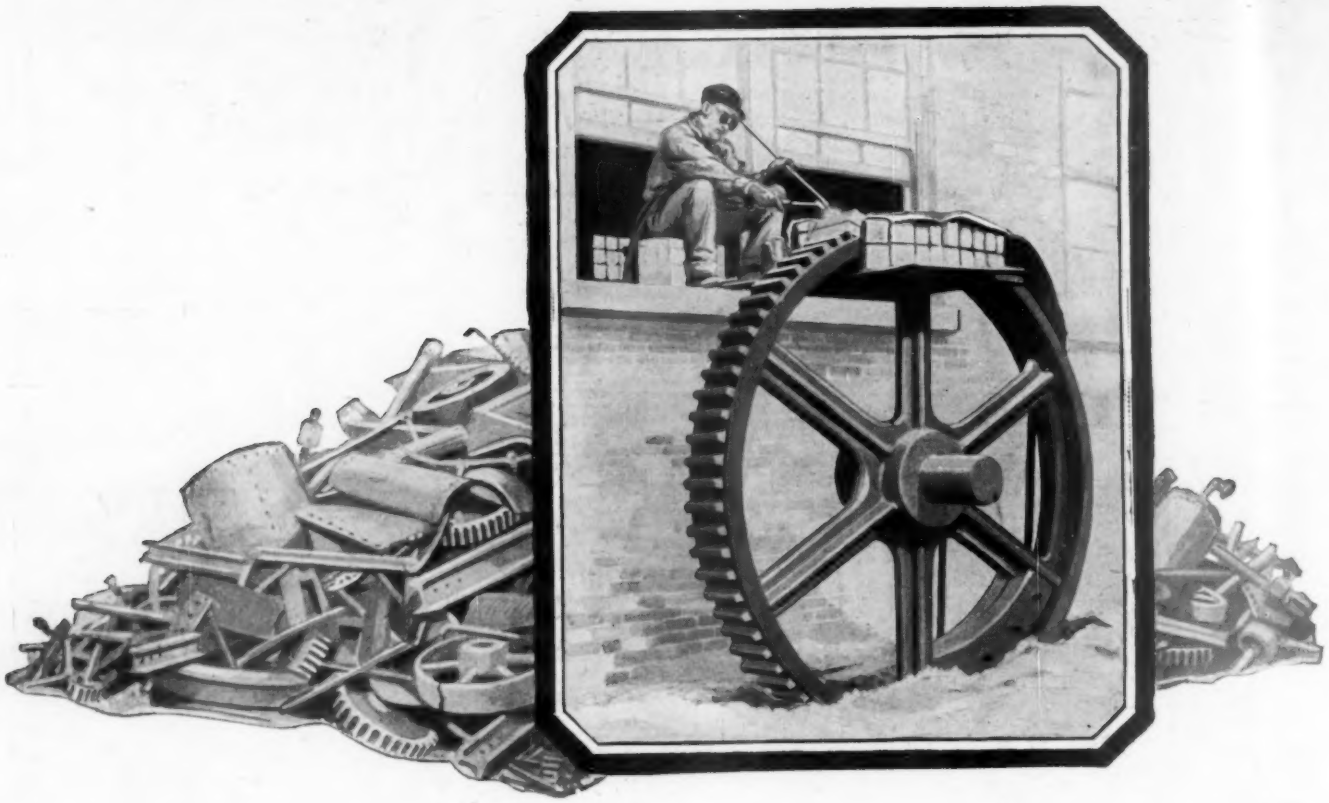

OXWELD~

an antidote for wear

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Yet, junking worn working parts is sheer waste.

In plants where Oxwelding is used, worn shafts, bearings, guides and gear-teeth are built up to their original dimensions in just a few hours — just as strong and every bit as serviceable as when they were first made.

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O-537

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Incorporated
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Canadian National Carbon Co., Limited
TORONTO

CARBON *in general is a highly refractory material, has a low coefficient of expansion due to heat, is mechanically strong, and can be obtained in many shapes and sizes.*

272044

Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

ACETYLENE (Compressed in Cylinders)
Commercial Acetylene Welding Co.
Universal Oxygen Co.
Prest-O-Lite Co.

ACETYLENE (Dissolved)
Air Reduction Sales Co.
Linde Air Products Co.

ACETYLENE CYLINDERS

ACETYLENE GENERATORS
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Bermo Supply Co.
Davis-Bournonville Co.
Reid-Avery Co.
The Alexander Milburn Co.
Oxweld Acetylene Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.

ALUMINUM FILLER RODS
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Burdett Oxygen Co.
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Davis-Bournonville Co.
The Imperial Brass Mfg. Co.
Hauck Mfg. Co.
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Kentucky Oxygen-Hydrogen Co.
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Imperial Brass Co.
Morey Flux & Chemical Co.
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Superior Oxy-Acetylene Machine Co
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

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Imperial Brass Co.
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Weldit Acetylene Co.

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Davis-Bournonville Co.
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Universal Oxygen Co.
Weldit Acetylene Co.

BLOW TORCHES (Acetylene)
See "Torches"

BOOKS (Relating to Welding)
The Welding Engineer
Electric Arc Cutting & Welding Co.

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Burdett Oxygen Co.
Cortland Welding Compound Co.
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Kentucky Oxygen-Hydrogen Co.

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We not only do welding, but supervise the design and installation of oxy-acetylene welding plants; report on welding material and methods; make tests on welding apparatus for efficiency and economy.

Nine years' experience.

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Superior Oxy-Acetylene Machine Co
Standard Mfg. Co.
Torchweld Equipment Co.
Universal Oxygen Co.
Weldit Acetylene Co.

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Burdett Oxygen Co.
Universal Oxygen Co.
Torchweld Equipment Co.
Weldit Acetylene Co.

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Hauck Mfg. Co.
Imperial Brass Co.
Superior Oxy-Acetylene Machine Co
Torchweld Equipment Co.

BRONZE FILLER RODS
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Wm. Cramp & Sons
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Bermo Supply Co.
Davis-Bournonville Co.
Kentucky Oxygen-Hydrogen Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

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Union Carbide Sales Co.

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National Carbon Co.
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Electric Arc Cutting & Welding Co.
Weldit Acetylene Co.

CARBON REMOVING TORCHES
See "Torches"

CAST IRON FILLER RODS AND FLUX
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Bermo Supply Co.
Burdett Oxygen Co.
Bierman-Everett Fdy. Co.
Cortland Welding Compound Co.
Wm. Cramp & Sons
Davis-Bournonville Co.
Kentucky Oxygen-Hydrogen Co.
Hauck Mfg. Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Imperial Brass Mfg. Co.
Superior Oxy-Acetylene Machine Co
Standard Mfg. Co.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

COPPER FLUX
Air Reduction Sales Co.

CUTTING RODS (Elec. Arc)
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Gibb Instrument Co.
Lincoln Elec. Co.
Quasi Arc Weldtrode Co.
Westinghouse Elec. & Mfg. Co.

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ELECTROLYTIC CELLS
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International Oxygen Co.
The Electrolabs Co.
Universal Oxygen Co.

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The Electrolabs Co.
International Oxygen Co.
Universal Oxygen Co.

FILLER RODS (Aluminum)
Air Reduction Sales Co.
Bierman-Everett Fdy. Co.

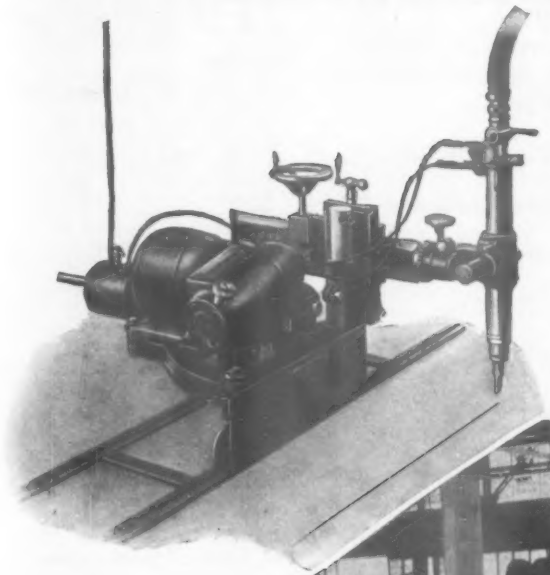
The Radiagraph Does It

With the Oxy-Acetylene Torch

It cuts steel plate, forgings, billets or risers, with a narrow kerf and finished surface, at uniform speeds, varying according to thickness of metal.

24-in. steel billets at	3 *in. per minute*
16-in. armor plate at	3 *in. per minute*
2-in. steel plate at	10 *in. per minute*
½-in. boiler plate at	20 *in. per minute*

Square or beveled cuts, along straight or irregular lines, or circular cuts, with equal facility.



The Radiagraph is a portable, motor-driven, self-contained oxy-acetylene or oxy-hydrogen cutting machine, used in shipyards, locomotive and car shops, boiler shops, and in fabricating plants generally, revolutionizing former methods with great time saving.

It is one of several exclusive developments of Davis-Bournonville for the greater application of gas cutting processes, which have proven invaluable in metal-working plants.

Illustrations show the Radiagraph in the Federal Shipbuilding Co.'s plant, trimming ship plate and cutting circular openings. Davis-Bournonville apparatus comprises the widest range of equipment manufactured for oxy-acetylene and oxy-hydrogen cutting and welding—from the portable one-man outfit to the complete installation of oxygen, hydrogen and acetylene generating systems with operating units for several hundred operators.

Write for Bulletins and Engineering Service.

Photos by Lionel Dottin, Federal Shipbldg. Co.

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Factories and General Offices, Jersey City, N. J.

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Boston
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Cincinnati
Cleveland
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Detroit
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DAVIS
APPARATUS
DAVIS-BOURNONVILLE CO. N.Y.

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St. Louis
San Francisco
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Imperial Brass Co.
International Oxygen Co.
Kentucky Oxygen-Hydrogen Co.
Rohde Laboratory Co.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

FILLER RODS (Swedish Iron)
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Burdett Oxygen Co.
Bermo Supply Co.
Wm. Cramp & Sons
Kentucky Oxygen-Hydrogen Co.
Electric Arc Cutting & Welding Co.
Davis-Bournonville Co.
Federal Tool & Alloy Steel Corp.
Hauck Mfg. Co.
The Imperial Brass Mfg. Co.
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Superior Oxy-Acetylene Machine Co.
Universal Oxygen Co.
Weldit Acetylene Co.

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Bermo Supply Co.
Bierman-Everett Fdy. Co.
Davis-Bournonville Co.
Kentucky Oxygen-Hydrogen Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

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Bermo Supply Co.
Burdett Oxygen Co.
Bierman-Everett Fdy. Co.
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Hauck Mfg. Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Reid-Avery Co.
Torchweld Equipment Co.
Superior Oxy-Acetylene Machine Co.
United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

FIREPROOF PLASTIC
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National Carbon Co.

FLUE WELDERS (Electric)
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FLUXES
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Cortland Welding Compound Co.
Anti-Borax Compound Co.
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Universal Oxygen Co.
Weldit Acetylene Co.

FURNACES (Annealing)
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Buffalo Dental Mfg. Co.
General Electric Co.
Hauck Mfg. Co.
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Giest Mfg. Co.
Hauck Mfg. Co.
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Superior Oxy-Acetylene Machine Co.
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GAS FLOW INDICATORS
Hanau Engineering Co.

GAUGES
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GENERATORS (Oxygen or Hydrogen)
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International Oxygen Co.
Universal Oxygen Co.

GLOVES (Welders Asbestos)
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Davis-Bournonville Co.
Electric Arc Cutting & Welding Co.
International Oxygen Co.
Imperial Brass Co.
Torchweld Equipment Co.
F. D. Farnum & Co.
Weldit Acetylene Co.

GOGGLES
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The Alexander Milburn Co.
Imperial Brass Co.
Willson Goggles, Inc.

GRINDING MACHINES

HARDENING FURNACES
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General Electric Co.
Hauck Mfg. Co.

HOSE (Oxygen and Acetylene)
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Burdett Oxygen Co.
Bermo Supply Co.
Buffalo Dental Mfg. Co.
Davis-Bournonville Co.
Kentucky Oxygen-Hydrogen Co.
International Oxygen Co.
Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.
Weldit Acetylene Co.

HOSE UNIONS
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Air Reduction Sales Co.
Bermo Supply Co.
K-G Welding & Cutting Co.
Hauck Mfg. Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
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Electrolytic Oxy-Hydrogen Laboratories, Inc.
International Oxygen Co.
Universal Oxygen Co.

HYDROGEN PLANTS
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Electrolytic Oxy-Hydrogen Laboratories, Inc.
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KEROSENE PREHEATING TORCHES
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Hauck Mfg. Co.
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Imperial Brass Co.
Oxweld Acetylene Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co.

NEEDLE VALVES
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Universal Oxygen Co.
Bermo Supply Co.
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Federal Brass Works.
General Welding & Eqpt. Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.

NICKEL FLUX
American Flux Co.

NITROGEN
Air Reduction Sales Co.
Linde Air Products Co.

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Aeroil Burner Co.
Air Reduction Sales Co.
Gas Products Assn.
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Oxweld Acetylene Co.
H. A. Smock
Superior Oxy-Acetylene Machine Co.

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Gas Products Ass'n.
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The Linde Air Products Co.
Swift & Co.
Universal Oxygen Co.

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Preheaters Giest Mfg. Co.

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Harris Calorific Co.
International Oxygen Co.
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Oxweld Acetylene Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co.
U. S. Gauge Co.
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Universal Oxygen Co.
Weldit Acetylene Co.

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Bermo Supply Co.
Burdett Oxygen Co.
Davis-Bournonville Co.
Federal Brass Works.
Hauck Mfg. Co.
Harris Calorific Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
K-G Welding & Cutting Co.
Oxweld Acetylene Co.
Smith's Inventions, Inc.
Superior Oxy-Acetylene Machine Co.
Torchweld Equipment Co.
United States Welding Co.
Universal Oxygen Co.
Universal Regulator Co.
Weldit Acetylene Co.

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Burdett Oxygen Co.
Bermo Supply Co.
Federal Brass Works.
Harris Calorific Co.
International Oxygen Co.
The Imperial Brass Mfg. Co.
Universal Oxygen Co.
Weldit Acetylene Co.
Universal Regulator Co.
Harris Calorific Co.
K-G Welding & Cutting Co.
Superior Oxy-Acetylene Machine Co.
Smith's Inventions, Inc.
Torchweld Equipment Co.
Universal Oxygen Co.
Weldit Acetylene Co.

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Bermo Supply Co.
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Universal Oxygen Co.
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The Thermalene Co.
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Universal Oxygen Co.
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Texas Headquarters for Welding and Cutting. The Best Equipped Plant in the State.

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Superior Oxy-Acetylene Machine Co
Smith's Inventions, Inc.
Torchweld Equipment Co.
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Universal Oxygen Co.
Victor Oxy-Acetylene Eqpt. Co.
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Torchweld Equipment Co.
Universal Oxygen Co.
Weldit Acetylene Co.

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THERMIT WELDING
Metal & Thermit Corp.

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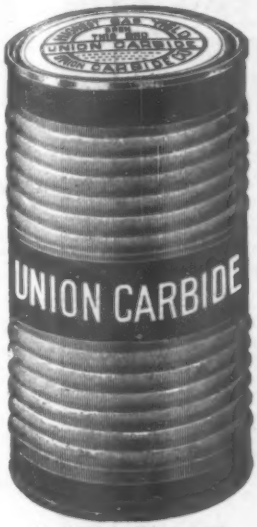
Buffalo Dental Mfg. Co.
The Imperial Brass Mfg. Co

Davis-Bournonville Co.
147 W. Austin Ave. Chicago

Davis-Bournonville Co.
Marion Jersey City

Davis-Bournonville Co.
316 Penn Ave. Pittsburgh



Packed in Blue and Gray Drums

Union Carbide Sales Company

New York City, Carbide and Carbon Building — **Chicago, Ill.,** Peoples Gas Building — **San Francisco, Cal.,** Kohl Building

SOLE DISTRIBUTORS OF

UNION CARBIDE

"World's Best Quality—Highest Gas Yield"

For Oxy-Acetylene Welding Plants

Contractors' Flare Lights, Torches and Private and Municipal Lighting Plants

"Union Carbide" is packed in 100-lb. blue and gray drums marked conspicuously, "UNION CARBIDE."

The following sizes are carried in stock in 100-lb. drums:

3½ x 2 in. —a large size.

2 x ½ in. —a medium size.

1¼ x ⅜ in. —an intermediate size.

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Phoenix—42 S. Central Ave.

ARKANSAS
Fort Smith—15 N. 4th St.

CALIFORNIA
Fresno—922 H St.
Los Angeles—629 Gibbon St.
Sacramento—1523-31 Front St.
San Diego—326-336 Fifth St.
San Francisco—Kohl Building.

COLORADO
Denver—Nineteenth and Wazee Sts.

CONNECTICUT
Hartford—412 Trumbull St.

DISTRICT OF COLUMBIA
Washington—Maryland Ave. and 9th St., S. W.

FLORIDA
Jacksonville—515 W. Bay St.
Tampa—107 Madison St.

GEORGIA
Atlanta—Cor. Haynes and Rhodes Sts., P. O. Box 1594.
Savannah—Ogeechee Canal, South of Bay St., P. O. Box 78.

ILLINOIS
Chicago—Peoples Gas Bldg., Michigan Blvd.
Decatur—133-147 W. Williams St.
East St. Louis—600 Walnut Ave.
Peoria—100-110 Edmund St.
Monmouth—124 E. Archer Ave.
Marion—315 S. Granite St., Box 747.
Quincy—222 S. Eighth St.
Springfield—217 S. 4th St.
Streator—501 East Hickory St.

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Fort Wayne—2216 Broadway.
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Terre Haute—921 Wabash Ave.

IOWA
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Dubuque—8th and Washington Sts.
Fort Dodge—10 S. 8th St.
Ottumwa—207-9-11 S. Washington St.
Sioux City—925 Fourth St., P. O. Box 398.
Waterloo—1209 E. 4th St.

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Pittsburg—109 W. Third St.
Salina—154 So. 5th St.
Wichita—Douglas & Sycamore Avenues, Post Office Box 951.

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Louisville—126 E. Main St.
Middlesboro—1701 Cumberland Ave.

LOUISIANA
New Orleans—4124 Toulouse St.

MAINE
Portland—11 Exchange St.

MARYLAND
Baltimore—19 E. Lombard St.
Cumberland—1 N. Liberty St.
Salisbury—Opp. Fulton Station.

MASSACHUSETTS
Boston—(See Cambridge "A.")
Cambridge—241 Albany St.
Springfield—Napier St.

MICHIGAN
Detroit—Federal and Junction Sts.
Grand Rapids—500 Shawmut Ave., N. W.
Hancock—First National Bank Bldg.
Iron Mountain—513 Stephenson Ave.
Jackson—172 South Water St.
Muskegon—303 W. Western Ave.
Saginaw—1220 No. Michigan Ave.
Sault Ste. Marie.

MINNESOTA
Minneapolis—334 N. First St.
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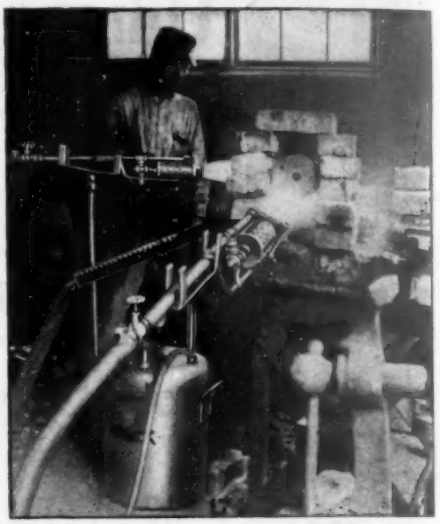

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ALPHABETICAL INDEX TO ADVERTISERS

A

Aeroil Burner Co. 58
Air Reduction Sales Co. 59
Anti-Borax Compound Co. 15
Alloy Products Co. 58
Atlantic Welding Works 4
Atlas Foundry Co. 58

B

Bastian-Blessing Co., The 30-31
Bermo Supply Co. 54
Bierman-Everett Fdy. Co. 9
The Buckeye Welding & Sup. Co. 58
Buffalo Dental Mfg. Co. 16
Burdett Oxygen Co. 20

C

Chicago Eye Shield Co. 57
Commercial Acetylene Supply Co. ..... Back Cover
Cortland Welding Compound Co. 49
Wm. Cramp & Sons 11

D

Davis-Bournonville Co. 5

E

The Electrolabs Co. 15
Electric Arc Welding & Cutting Co. 47

F

F. D. Farnam & Co. 16
Federal Brass Works 17
Federal Tool & Alloy Steel Corp. 49

G

General Electric Co. 32
Giest Mfg. Co. 35
General Welding & Equipment Co. 29
Gas Products Assn. 13
Gas Tank Recharging Co. 11
Gibb Instrument Co. 21

H

Harris Caloric Co. 57
Hauck Manufacturing Co. 8
Hydrex Engineering Co. 56

I

Imperial Brass Mfg. Co. 18
International Oxygen Co. 57

K

Kentucky Oxygen-Hydrogen Co. 55
K-G Welding & Cutting Co. 21

L

Linde Air Products Co. 22
Lincoln Electric Co. 14
L. Lawrence & Co. 53

M

Metal & Thermit Corp. 19
The Alexander Milburn Co. 41
Morey Flux & Chemical Co. 58
Modern Engineering Co. 49

N

National Carbon Co. 3

O

Oxweld Acetylene Co. 2

P

Page Steel & Wire Co. .....
Portland Brazing Machine Works 4
The Prest-O-Lite Co., Inc. 39

Q

Quasi Arc Weldtrode Co. 41

R

Reid-Avery Co. 10
Rohde Laboratory Supply Co. .....
Rockgas Products Co. .....
Rochester Welding Wks. 4
John A. Roebling's Sons Co. .....

S

Smith's Inventions, Inc. 10
H. A. Smock 58
Superior Oxy-Acetylene Machine Co. 51
Sorenson, C. .....
Southern Welding Machine Co. 6
Swift & Co. 17
Standard Mfg. Co. 58
Shawinigan Products Corporation 16

T

The Thermalene Co. 58
Torchweld Equipment Co. ..... Front Cover
Transportation Engineering Corp. 8

U

Union Carbide Sales Co. 7
United Marine Contracting Corp. 15
U. S. Gauge Co. 9
United States Welding Co. 56
Universal Oxygen Co. .....
Universal Regulator Co. .....

V

Victor Oxy-Acetylene Eqpt. Co. .....

W

Westinghouse Elec. Mfg. Co. 12
Weldit Acetylene Co. 15
Wm. Wharton, Jr., & Co., Inc. 57
Willson Goggles, Inc. 47

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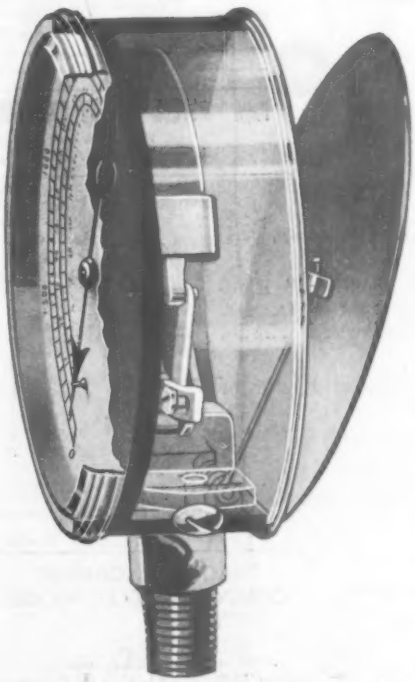

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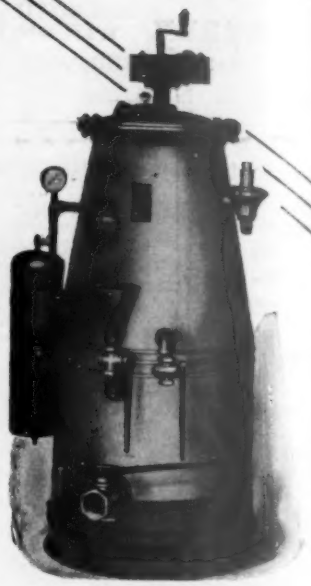

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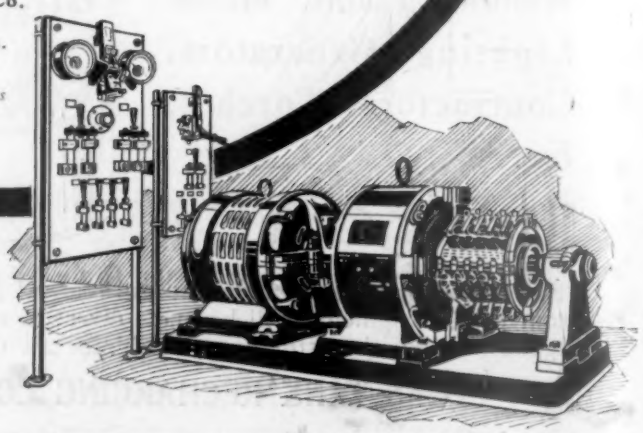

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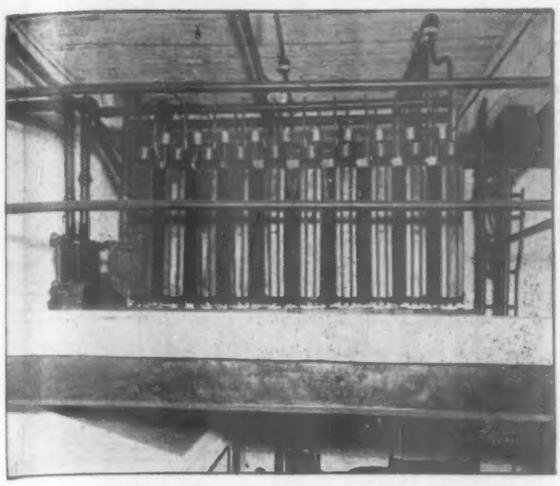

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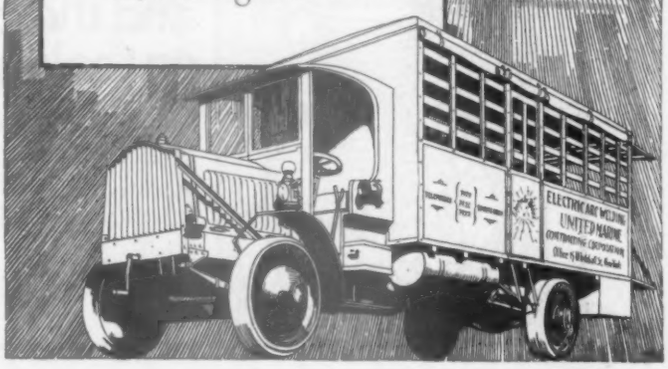

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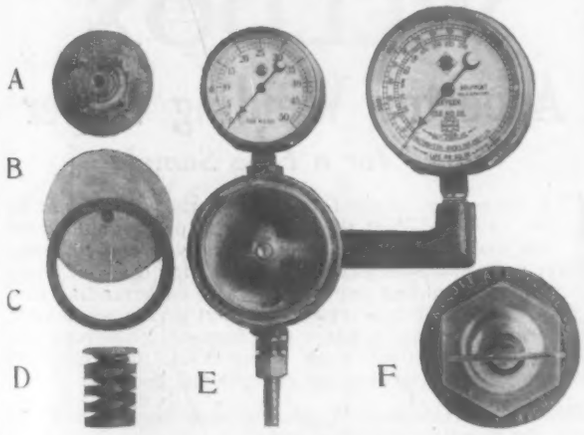

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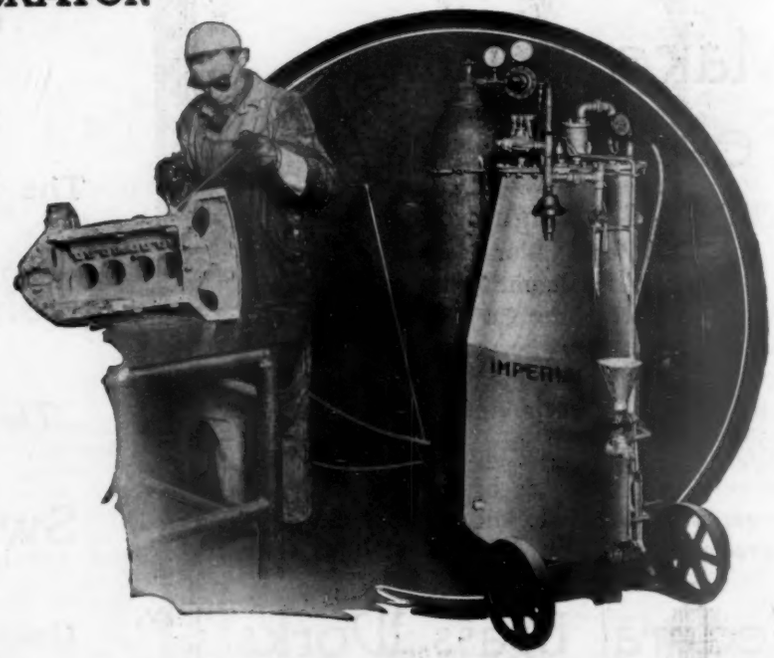
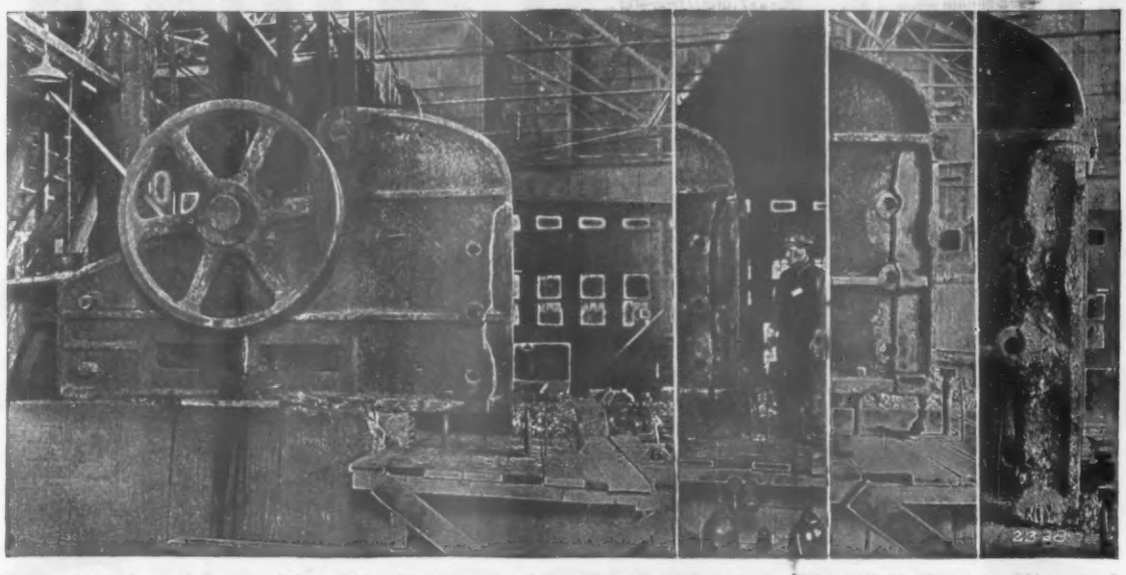
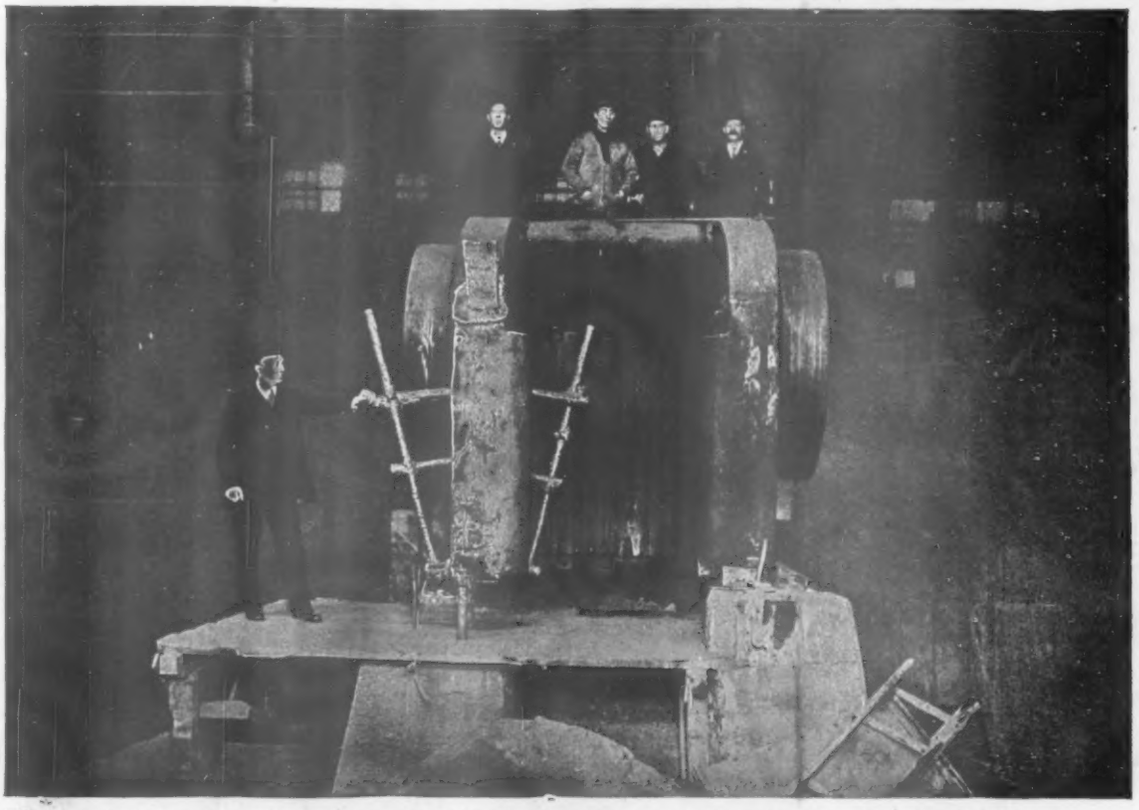




Illustrations from left to right show fracture, sections aligned with gap for Thermit steel, wax pattern and finished Thermit weld



Completed weld, showing gates and riser—about half a ton of Thermit steel used to make the weld

The illustrations show an emergency Thermit repair of broken side frame of large crusher for International Nickel Company, Bayonne, N. J. Broken section about 6 feet high by 3 to 8 inches thick. Side frame welded in place. 1,500 lbs. of Thermit. Crusher restored to operation as good as ever.

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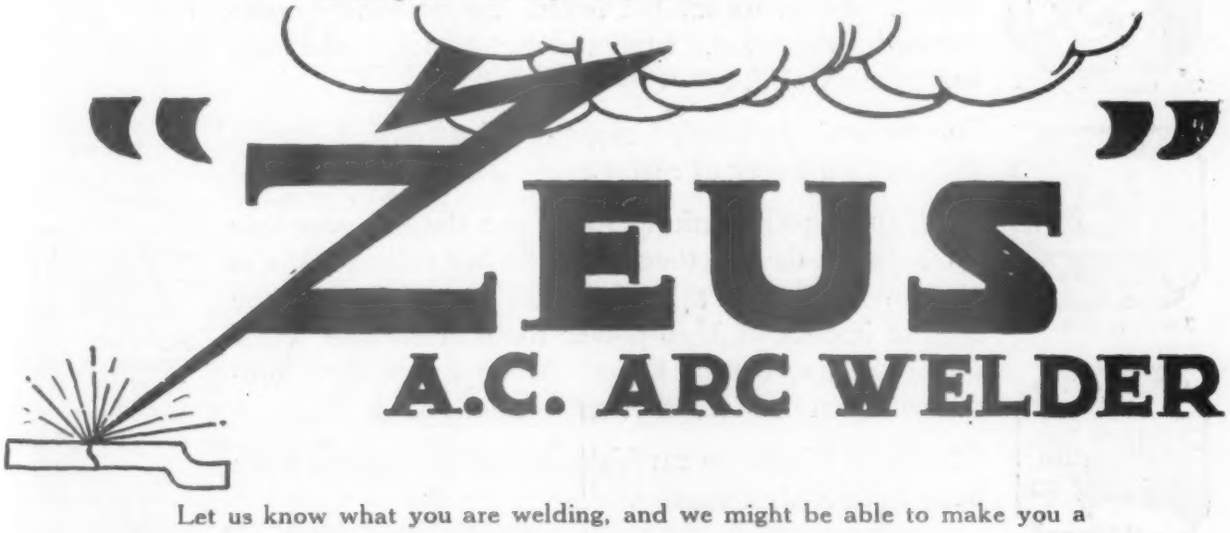
This was the proposition we made one manufacturer.

We made good—he kept the welder.



Let us know what you are welding, and we might be able to make you a proposition which business judgment may force you to accept.

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The Knight in Armor

The Early Railroad

The Modern Steel Mill

WHEN Man, the most helpless of all animals, discovered fire, he took the first great step toward supremacy.

Not because fire enabled him to cook his food, not because it kept his cave warm—but because it gave him the mastery of metal.

The tough hides of primeval monsters, proof against the most skillfully carved bone, yielded to the iron spear head. The flint arrow head fled before the bronze sword. Barbarity melted before the onrush of steel-encased civilization. Man and metal became the masters of the world.

But not until the Linde Company industrialized oxygen did man's mastery of metal become complete.

With this epoch-marking step came the oxy-acetylene torch and to-day the toughest of known substances is as clay in the molder's hands. Steel, unscathed by the terrific impact of high-power shells, runs like water under the tiny cutting flame. Metal is added to, subtracted from or divided as meets man's needs.

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PROCEEDINGS *of the* AMERICAN WELDING SOCIETY

33 West 39th Street, New York

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AMERICAN WELDING SOCIETY
1920—1921

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C. A. Adams, Junior Past President
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Edward A. Miller, Chairman Meetings and Papers Committee.
A. S. Kinsey, Chairman, Welding Conference Committee.

NATIONAL RESEARCH COUNCIL

As the National Research Council may not be well known to many members of the Welding Society, the following is a brief outline of its history, organization and accomplishments.

The National Research Council came into existence with the war in the spring of 1917, when President Wilson requested the National Academy of Sciences to assist in organizing the scientific and engineering forces of the United States for the purposes of defense.

The National Research Council was accordingly formed with eight divisions. The Division of Engineering, one of the eight, did effective work in many directions throughout the war.

In 1918, President Wilson issued an executive order requesting that the National Research Council be perpetuated. Following this, the effecting of the permanent organization of the council was rapidly accomplished. The council, as now organized, consists of thirteen divisions; six of these deal with general relations and seven with science and technology. The divisions of science and technology cover the whole field of pure and applied science. One of the most important of this group of divisions is the Division of Engineering.

The National Research Council is in reality a federation of research interests whose purpose it is to promote research in the mathematical, physical and biological sciences and in the application of these sciences to engineering, agriculture, medicine and other useful arts, with the object of increasing knowledge, of strengthening the national defense and of contributing in other ways to the public welfare.

Although the government contributed to the financial support of the National Research Council during the war period and the council, in turn, co-operated in the freest manner with the various governmental departments and bureaus, it is not a government organization and is now supported by private endowment.

The chief source of this endowment is a sum of $5,000,000 donated by the Carnegie Foundation. Of this sum about $1,000,000 will be expended for a suitable building to house the National Academy of Sciences and the National Research Council. The revenue from the remainder will be available for the administrative expenses of the council.

All of the divisions of the council with the exception of the Division of Engineering are located in Washington. In order to maintain the desirable close relationship with the engineering societies, the Division of Engineering has its offices in the Engineering Societies Building in New York.

The Engineering Foundation, which is closely affiliated with the Engineering Division of the National Research Council and whose offices adjoin that of the division, contributes a portion of the funds needed for the administrative expenses of the division. It also supports certain research work of the division. For example, it is now contributing $15,000 per year for the research work of the Committee on Fatigue Phenomena of Metals.

In general, however, the funds needed for research work must be contributed by the interested industries.

The officers of the Engineering Division are:

Prof. C. A. Adams, chairman.
Dr. H. M. Howe, honorary chairman.
Mr. G. H. Clevenger, vice-chairman.
Mr. Wm. Spraragen, secretary.

The members of the Engineering Division is made up largely from representatives appointed by the following Engineering Societies: American Society of Civil Engineers; American Institute of Electrical Engineers; American Society of Heating & Ventilating Engineers; American Society of Mechanical Engineers; American Society of Mining Engineers; American Society of Refrigerating Engineers; American Society for Testing Materials; Illuminating Engineering Society; Western Society of Engineers; Society of Automotive Engineers. (Representatives of other societies will be added from time to time.)

In addition to the representatives from the Engineering Societies, there are a number of members at large appointed because of their special fitness. The membership includes some fifteen past presidents of the Engineering Societies, high officials of government departments, and leaders of our industries.

The Division of Engineering is working in close co-operation with each engineering society in stimulating and co-ordinating research work in its particular field.

The work is now being organized on a group basis as follows: In each general field, there will be a general advisory committee (with a small active executive committee) under which will be organized the several research committees.

In addition to its functions in connection with the research committees, the General Advisory Committee in any field will also be the agency through which the Engineering Division will spread throughout the industries an appreciation of the value of research and to stimulate the industries themselves to conduct the more commercial forms of research.

The feasibility and economy of co-operation in fundamental engineering research is now a demonstrated fact and is without doubt the only economically rational plan that can be employed in the advancement of a new art such as welding or in some of the older arts where the present scientific knowledge is limited.

PROPOSED NEW ORGANIZATION OF THE AMERICAN BUREAU OF WELDING

A plan for the reorganization of the American Bureau of Welding is now being proposed by Professor C. A. Adams, director of the Bureau.

This plan is briefly that the Bureau be organized as the general welding research advisory committee of the American Welding Society, and also of the Engineering Division of the National Research Council. The members of this committee or Bureau would be made up of representatives appointed by all interested societies and organizations and a certain number of members at large chosen for their special ability and interest in welding matters. The dominant representation, however, would be from the American Welding Society, as it is the society most interested.

Following the general plan of the Engineering Division of the National Research Council it would be the function of the general Committee of Bureau to prepare a program of activities and research work, to devise ways and means of organizing, financing and conducting such activities, and in general to act as an advisory body to the various sub-committees that it would appoint to deal with specific problems relating to welding matters. The personnel of these sub-committees need not, however, be confined entirely to members of the Bureau. The American Welding Society as the organization most vitally and broadly interested would be the sponsor body and would publish the work of the Bureau in its proceedings.

The new organization proposes to have the Welding Society representatives on the Bureau selected (by the Board of Directors of the society) for their special fitness rather than having the whole Board of Directors serve as the society representatives, the qualifications desirable for members of the Bureau being different from those desirable for members of the board. Moreover the new plan will enlist the services of a larger group and distribute the total work equitably and efficiently rather than adding materially to the duties of already busy board members.

Another feature of the new plan is to have at least one member of each section of the society on the Bureau, who should preferably be the chairman of the Research Committee of the section.

Under the old plan the Research Committee of the Bureau is the Welding Research Committee of the Engineering Division of the National Research Council, whereas under the new plan the Bureau itself will be the general welding advisory committee of the Engineering Division, as well as of the Welding Society. It should be noted that the present director of the Bureau is chairman of the Division of Engineering of the National Research Council and that the secretary of the division, Mr. Wm. Spraragen, is acting secretary of the Bureau.

The chairman of the division devotes a very appreciable part of his time to the work of the Bureau and of the society, and the secretary of this division devotes about half of his time to the work of the Bureau, both without cost to the bureau or society. Thus the office of the division is for all practical purposes the office of the Bureau. Fortunately the office of the division adjoins the office of the Welding Society, which makes co-operation very effective.

It is thus obvious that the proposed plan of reorganization of the Bureau of Welding is a natural result of the situation and relations above set forth.

The official connection with the National Research Council will add prestige to the Bureau and weight to its proceedings or pronouncements. This will also constitute a material asset of the Welding Society.

The new scheme of organization has been heartily endorsed by a number of the older members. A tentative program of activities for the Bureau has been drawn up by Messrs. C. A. Adams, H. Lemp, S. W. Miller, C. A. McCune, H. L. Whittemore and W. Spraragen and is given below:

1. Standardize welding procedure, in so far as possible, for each process and for each application of the process in order that users may have the best available instruction for the work.

Note: Research data is needed for the completion of these standardizations. Some of these investigations have been started by the Bureau.

2. Compilation of data as to strength, ductility, etc. of welds made by the various methods; also such data as will enable user to estimate cost of welding by the various methods. This data should be so arranged in tables and curves as to be most expressively and conveniently useful for the various conditions and types of work met in practice. It should also be accompanied by such information and references as to the various tests recorded as will enable the reader to judge intelligently of the value of the resulting data.

3. Develop a standard training course by obtaining from the railroads training schools, and other sources copies of methods of welding instructions, and from them and other experience make up a set of instructions, giving proper credit for the ideas and methods selected. This course shall also include inspection training.

4. Collection of impartial information and data, based on tests of welding apparatus, including such data as efficiencies, pounds of metal deposited per hour and per k. w. hour under specified conditions, power factor of a. c. apparatus, cubic feet of gas per hour and per pound of metal deposited; data on apparatus and material needed for other processes of welding such as thermit, spot electro-percussive, automatic arc, etc.

5. Compilation of impartial information on welding materials such as fluxes, gases, electrodes and welding rods. (Note: Certain research work will have to be carried out in this connection.)

6. Standardize methods of inspection and testing of welds.

7. Make sets of sample fractured welded test specimens of specified materials made by standard procedure which will be furnished to those interested upon payment of a proper fee. (Note: The Bureau of Standards standard sample of steels have been of immense value to the steel industry.)

8. Revise and standardize welding nomenclature.

NEW YORKERS TO HAVE LOCAL SECTION

Although the National Organization of the American Welding Society has its office in New York City, there is no local organization to look after the Metropolitan district and its environs.

Sections of the society have already been organized in Philadelphia, Chicago and Pittsburgh, and several other sections are now in process or contemplation.

Great enthusiasm is in evidence in all of the sections, and the membership is increasing rapidly in their several districts.

In order that New York may be as progressive in caring for its local interests as other cities, it has been decided that a New York section should be organized.

A representative group of men has been asked to meet on Thursday, October 14th, at the Engineering Societies Building, New York City, to plan the organization of the New York section.

Welding as applied to frame making and repairing was discussed by Mr. F. F. Hoeffle, of the L. & N. R. R., and Mr. G. W. Kelley, of the Central Railroad of New Jersey, at the recent meeting of the International Railroad Master Blacksmiths' Association at Detroit.

PHILADELPHIA SECTION OFFICERS

The following officers have been elected by the Philadelphia Section of the American Welding Society:

Officers (To serve for one year)

Chairman—Joah Brogden, David Lupton's Sons Co., Allegheny Avenue and Tulip Street, Philadelphia, Pa.

First Vice-Chairman—Lt. Comdr. E. F. Enright, C. C., U. S. N., Philadelphia, Pa.

Second Vice-Chairman—Dr. H. S. Lukens, University of Pennsylvania, Philadelphia, Pa.

Secretary—H. J. Grow, 5001 Walnut Street, Philadelphia, Pa.

Treasurer—C. W. Bates, Philadelphia Electric Co., 226 S. 11th Street, Philadelphia, Pa.

Executive Committee (To serve for three years)

G. P. Mills, General Electric Co., Philadelphia, Pa.

W. W. Barnes, Davis-Bournonville Co., Philadelphia, Pa.

Victor Mauck, John Wood Mfg. Co., Conshohocken, Pa.

W. T. Bonner, Berkeley Chambers, 500 Broadway, Camden, N. J.

(To serve for two years)

D. C. Anderson, Lincoln Electric Co., Philadelphia, Pa.

T. M. Jackson, Sun Shipbuilding Co., Chester, Pa.

H. F. Weldin, Air Reduction Sales Co., Germantown and Allegheny Avenues, Philadelphia, Pa.

Jos. Meadowcroft, Edward G. Budd Mfg. Co., 25th and Huntingpark Avenues, Philadelphia, Pa.

(To serve for one year)

C. J. Mooney, Linde Aid Products Co., 18th and Cambria Streets, Philadelphia, Pa.

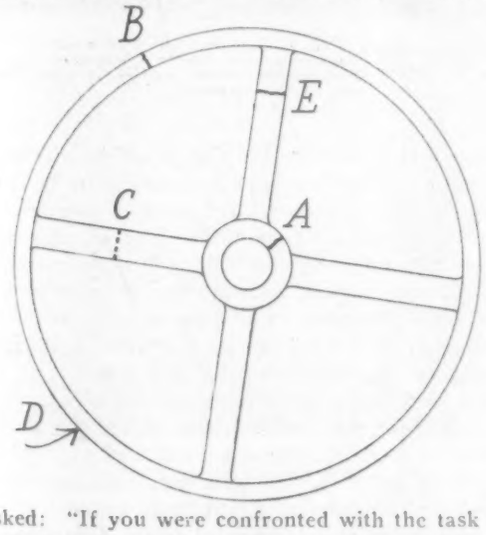
G. W. Scott, Wm. Cramp & Sons S. E. B. Co., Beech and Palmer Streets, Philadelphia, Pa.

F. W. Anderson, Atlantic Refinery Co., 3144 Passyunk Avenue, Philadelphia, Pa.

L. H. Swind, Swind Machinery Co., Widener Building, Philadelphia, Pa.

CHICAGOANS DISCUSS PREHEATING

A lively discussion of preheating problems and theories constituted the program of the American Welding Society, Chicago Section, at the regular monthly meeting, Tuesday evening, October 12th. A sketch of the fly wheel shown in the illustration was put on the board and the welders present



were asked: "If you were confronted with the task of welding this broken fly wheel would you preheat, and how, where and why?" The question proved to be one of considerable interest, and there was a wide difference of opinion evident in the various answers presented. A stenographic report of the discussion will be published in *The Welding Engineer* The meeting was well attended and several new memberships were accepted after the regular business had been finished.

THE BRAZING OF CAST IRON

By A. E. DeBurn

To thoroughly understand what takes place when the brazing of cast iron is attempted, it is necessary to delve somewhat into the metallurgic structure of cast iron.

As we all know, cast iron and steel are developed from the same base metal, iron and carbon is contained in each. Steel has up to 2 per cent carbon, while cast iron rarely contains under 2 per cent. Of the other components, silicon, manganese, sulphur, and phosphorus, we will say nothing, as their action is quite complicated and has no special bearing in this discussion.

In brazing we use carbon, usually in the form of graphite, to protect machined surfaces, threads, and any portion of the metal we wish from the adherance of the flowing flux and melted filler. For we all know that brass or bronze will not "take" to graphite or carbon.

All the carbon in steel is in the form of carbide of iron (Fe_3C called Cementite) and when cold, steel consists of a mass of grains of ferrite (pure iron) surrounded by films of cementite (carbide of iron). There is no change in this cold solution when heating until about 1,300° F. is reached, at which point the ferrite starts to disolve the cementite, continuing such action until 1,480° F. is reached at which temperature the carbide of iron, or cementite, is all disolved in the solution. This action takes place under the heat of the blow pipe when we are preheating to braze, and we have combined carbon, disolved in iron, the pores of which are expanded and ready to receive the cleansing flux and brass on bronze filler.

The process with cast iron is somewhat analogous except that most of the carbon in cast iron is in the form of graphite which we all know has no affinity for brass. The softer the cast iron the more carbon is contained in graphite form; and the slower a casting is cooled the more free graphite is formed.

So in soft, cold cast iron we have under the mircroscope, large, irregular grains of ferrite with nothing between them; but with great dark bloches or plates of graphite plainly visible.

If a piece of cast iron is heated even to 1800°F. the resultant structure is still mostly ferrite and our enemy to brazing. i. e.: graphite. Heating or tempering may change the grains to pearlite, form austenite and cementite, but the excess of carbon in graphite form still remains.

Therefore, even though cast iron is heated from ordinary temperature to melting point, quenched or cooled slowly, the free graphite is present at all times to such an extent that proper adherence of brass or bronze cannot take place.

Malleable iron, having had the free graphite removed from the outer surface in the heat treatment of manufacture, can be readily brazed, as the surface is, and acts the same as, iron or steel under heat.

AIR REQUIRED TO OPERATE THERMIT WELDING PREHEATERS.

The following data is the result of some recent tests made by the Metal & Thermit Corporation, New York, N. Y., to determine the proper amount of air required for special thermit welding gasoline and compressed air preheaters.

Twenty-five pounds per square inch seems to be a practical minimum for operating preheaters. At this pressure, a single-burner preheater will require approximately 25 cubic feet of free air per minute and a double-burner preheater approximately 50 cubic feet of free air per minute. For very large welds, where the walls of the molds are thick and the preheater gates longer than usual, a pressure of 40 pounds per square inch would be advisable, which would require approximately 35 cubic feet of free air per minute for a single-burner preheater and 70 cubic feet of free air per minute for a double-burner preheater.

TESTING WELDS*

By S. W. Miller, M. E.*

THE question of testing welds is one that has been considered more or less since welding was known, but especially during the past five years. Its importance has now become very great. There have been many failures in the past, many of them not having been explained and some of them having been very expensive. As in all other developments, welding first received its principal impetus from the practical man. Of late, however, the tendency has been to investigate more carefully and more fully and by means not available to the ordinary welder. This means that scientists of all kinds have been called into consultation and that almost every conceivable method of test has been suggested in order to determine what methods and materials would make the best welds both from a standpoint of security, service and cost. While some of the methods employed at present are beyond the reach of the ordinary welding shop yet they are of great value and, in fact, necessary in order to determine correctly what has occurred during the welding operation and what results may be expected under given conditions. Serious criticism of most of the published results can be made because of their incompleteness in one or more respects and one of the things that the American Welding Society proposes to do is to put the testing of welds and welded structures on a firm and safe foundation.

The testing of metals, aside from welds, is quite well developed both in theory and practice. The usual test is the tensile that gives the tensile strength per square inch, the yield point or elastic limit in pounds per square inch, the elongation in per cent of the original gauge length and the reduction of area in per cent of the original section. Compression, torsion, shock and alternating stress tests are also used and the two latter are beginning to be used much more than they have in the past because it has been found that materials may give high results in the tensile test and yet be entirely unsuitable to resist service where shock or alternating stresses are met. Another of the common tests is bending to a certain radius either hot or cold and it has been found that it is a very valuable test of certain qualities.

Chemical analysis is another powerful method of investigation and many specifications have been made in which its use is vital.

The microscope has been found to be of tremendous help in the study of metals and in fact it is now a necessary instrument in all laboratories. Its principal function is to determine the extent and location of impurities in a metal, to decide whether the structure is proper for the purpose desired and to decide whether various heat treatments will give satisfactory results. While no one method of test shows everything desired to be known, the microscope is probably the most powerful single method of investigation in the case of metals, and in the study of welds it is particularly valuable because of the method of their formation. A weld is a casting and is subject to all the defects found in castings which are, however, exaggerated in the case of welds. It would be impossible in the time allowed to consider the defects in welds in all metals made by all welding processes and I therefore feel that it will be wise to confine my talk tonight to the welding of steel plate by the O. A. and metal electrode processes. Let us also consider that the welds we are to talk about are to be those in some important structure so that soundness and high quality are necessary. By soundness, I mean freedom from mechanical imperfections such as lack of fusion, the presence of films or other inclusions, gas pockets, slag, etc. It is not forgotten that welds of inferior quality may answer some purposes admirably and that if they do, there is no use in making better ones, but this is not the goal at which to aim for one who desires to make really good welds. The welding of steel is frequently considered as not being especially difficult and it is also sometimes considered that steel is steel and that no different treatment is required in the case of different qualities and varieties of steel. This idea is much less common today than it was several years ago, but it is still too prevalent for the good of the art. It is not as well known as it should be that a comparatively small difference in the percentage of carbon in the material being welded makes a very great difference in the results of either a bend or tensile test. If the carbon is .12 per cent or less, the material is soft, ductile and yields readily to any strain that may be put on it. Such

Fig. 1. Flaky gun steel. Films of oxide or slag, which weaken the metal, and prevent it passing test.

Fig. 2. Strained piece of gun steel showing rupture beginning at small defects, two small dots of manganese sulphide.

Fig. 3. Another piece of strained gun steel. Rupture occurs here in a streak of ferrite, which contains no carbon, and so is weaker than the rest of the material.

**A paper read before the September meeting of the Chicago Section of the American Welding Society.*

†Mr. Miller is proprietor of the Rochester Welding Works, Rochester, N. Y., and is regarded as being one of America's foremost authorities on the subject of autogenous welding.

material is frequently used for tanks and because of its ductility and comparative freedom from damage by heating, is admirably suited for welding. Structural steel, bar steel and boiler plate contain about .15 per cent to .25 per cent carbon and have a tensile strength of about 60,000 lbs., while the soft low carbon material has only about 52,000 to 55,000. Ship plate is required to have a T. S. of from 58,000 to 68,000 lbs. and in the heavier sections requires as high as .30 per cent carbon. It has been found by experience that the higher the carbon, the more difficult it is to get a satisfactory weld and the more danger there is of injuring the metal being welded. From a metallurgical point of view this is entirely natural and to be expected. It is also evident that a weld made with a given welding rod or electrode can have only a given strength. If this strength is greater than that of the material being welded, the test piece will always break outside of the weld. If, on the other hand, the weld is weaker than the material being welded, the rupture will always take place in the weld. An O. A. weld made with ordinary low carbon welding wire will have a tensile strength of about 52,000 lbs. This is stronger than soft tank steel and weaker than the other materials mentioned. It is possible to get with alloy steel rods of proper composition a tensile strength in an O. A. weld of about 50,000 lbs. Neither of these materials will weld boiler steel, boiler plate or ship plate, so that the rupture will occur outside the weld when the section of the weld is the same as the section of the piece, so that in making tests of welded pieces, it is necessary to know accurately the character of the material being welded because if Welder Jones makes a weld in soft tank steel and Smith makes one in bar steel the first will break outside of the weld and the latter in the weld with a probable adverse criticism of Smith's work. The method of test to be applied in any given case depends largely on the use to which the welded piece is to be put. If it is to be used in a pressure vessel, I believe that not only should a tensile test be made but that an alternating stress test should be used because of the breathing of the tank due to changes of pressure. This latter test should also be applied where the weld is subjected to bending strain. There are no standards at present for weld tests but it is advisable, whenever possible, to follow those of the A. S. T. M. Inasmuch as a welded piece is not of uniform character, it is not possible to use the elongation and reduction of area as commonly measured. Where the break occurs in the weld, the elongation of the whole test piece tells very little about the quality of the weld and I have been in the habit of taking the elongation in each inch, two inches, etc., of the gauge length beginning at the center inch which includes the weld, and plotting these figures against the gauge length. Evidently, when the break is outside the weld,

Fig. 4. Armco iron strained. The curved lines are not cracks, but the edges of parts of the grains that have slipped past each other, so that the surface of each grain is stepped, as would be the top of a row of books that had slid past each other. In some grains there are two sets. They are called slip bands.

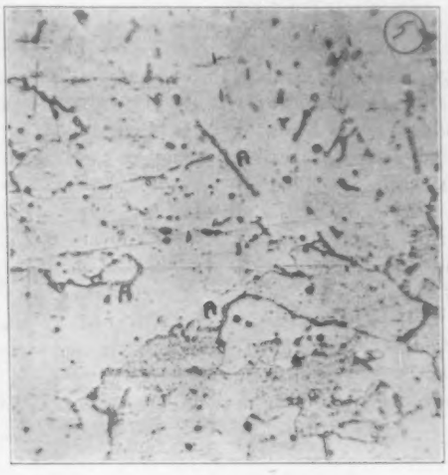


Fig. 5. A better oxy-acetylene weld than Fig. 6, but in the same material. Note the absence of iron nitride lines. The small dark dots are iron oxide, and they appear in all welds. The bands A at the grain boundaries are carbide of iron, or cementite, and contain all the carbon in the steel. There are more of them than in Fig. 6, showing more carbon present, and also that the metal was not as hot as in Fig. 6, because overheating burns out the carbon.

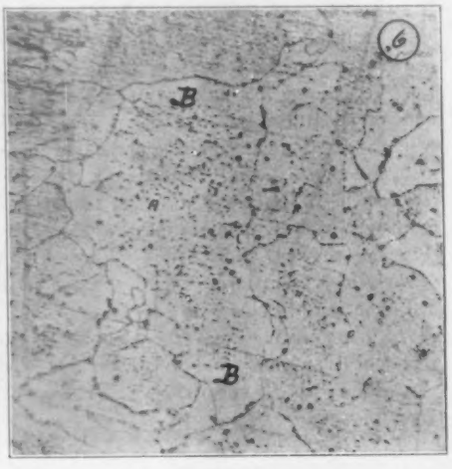


Fig. 6. A good looking oxy-acetylene weld, but made with too large a tip, as shown by the short straight lines in some of the grains, as above and below A, in the large grain B. These lines are iron nitride, and indicate absorption of both nitrogen and oxygen by the overheated metal. The grain boundaries are the irregular curved lines.

Fig. 7. Slip bands in good oxy-acetylene weld, stopping at grain boundaries.

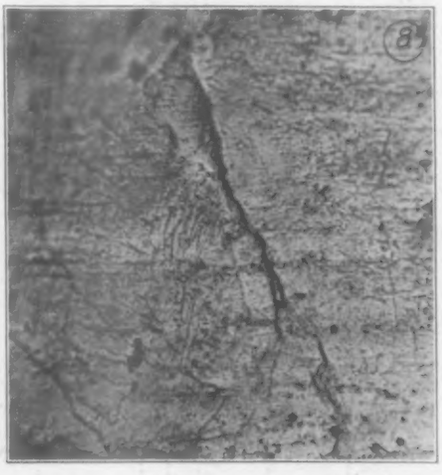


Fig. 8. Oxy-acetylene weld showing heavy slipping at grain boundary. This is not a crack, but shows a weakness there.

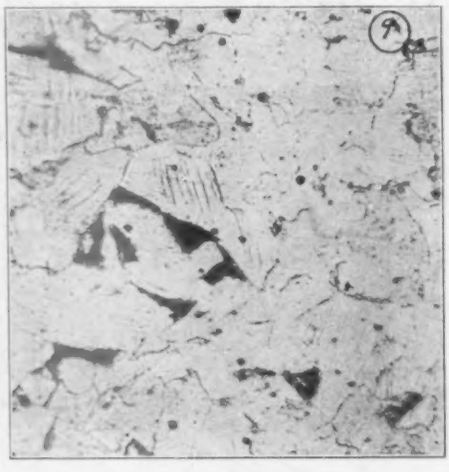


Fig. 9. Good oxy-acetylene weld made with rather high carbon steel, as shown by the pearlite grains A. Note presence of slip bands in all good welds, and their absence in bad ones.

the various physical characteristics are those of the original material and not at all of the weld. The best test, in my opinion, to determine quickly the general character of a weld, is to grind it off level with the surface of the pieces and clamp it on an anvil, with the center of the weld level with the top of the anvil, the bottom of the V toward the anvil so that the top of the weld is stretched when the projecting end is struck with a sledge. The blow should not be too heavy and the number of blows and angle to which the piece bends before cracking are quite a good index of the value of the weld. It is true in this test, as in the tensile tests, that the quality of the material being welded has a great influence on the results. Stiff material throwing more of the strain into the weld while soft ductile material will itself take considerable of the bend. In the case of defective welds, that is, those not fused along the V or which contain slag or other inclusions, this test will at once develop the defects. If a welded piece were to be used in a place where it might become red hot such as, for instance, in a locomotive fire box crown sheet, it would be entirely proper to test the weld at a good red heat and I believe that it would be of much interest to all of you, if you would test some of your welds by clamping them in a heavy vise or on an anvil with the center of the weld about half an inch from the edge of the table or above the face of the anvil, heating them to a bright orange with the torch and then bending them as before as with a sledge.

If such welds are made in half inch by two inch bar steel, a 90 degree single V being used, and they bend to a right angle cold without cracking on the outside, a welder may feel well satisfied with his work.

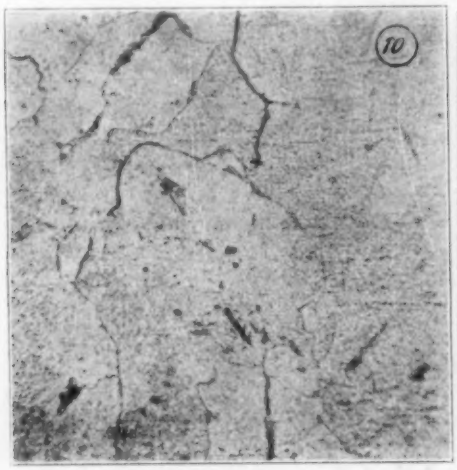


Figure 10.

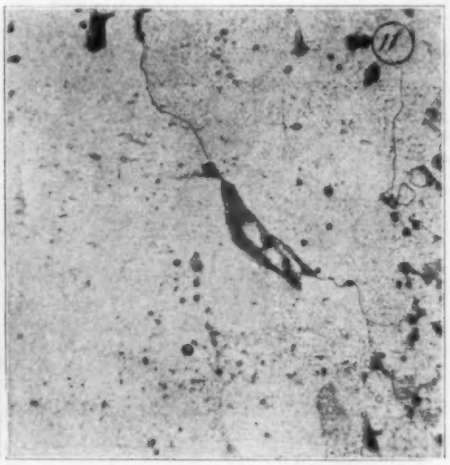


Figure 11.

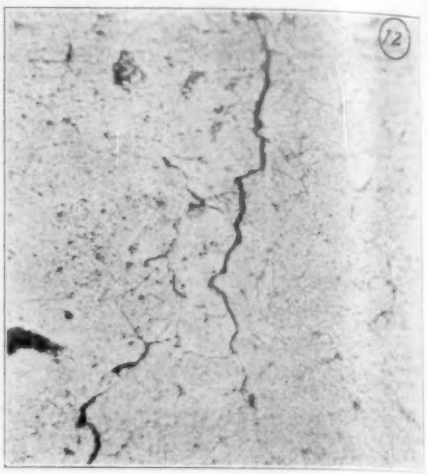


Figure 12.

Fig. 10. Inter-granular cracks in strained oxy-acetylene weld.

Fig. 11. Film of foreign matter, probably oxide, in oxy-acetylene weld.

Fig. 12. Inter-granular cracks in strained oxy-acetylene weld. No defects visible before straining, showing that films were very thin.

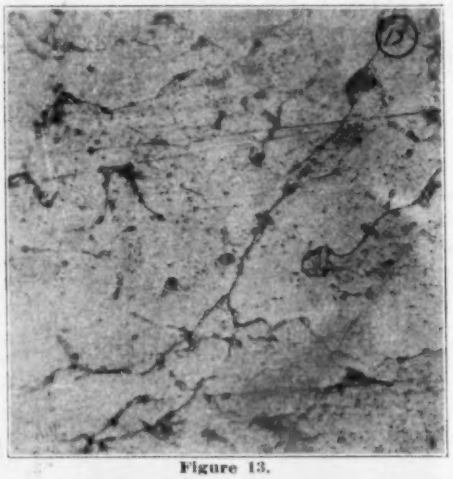


Figure 13.

Figs. 13 and 14. Visible defects in oxy-acetylene weld before and after straining.

Figs. 15 and 16. Are the same field, 16 being strained more than 15. Rupture is inter-granular. Note in 16 that upper part is lifted out of the lower.

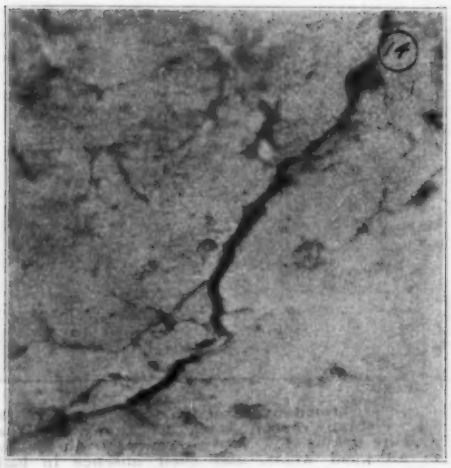


Figure 14.

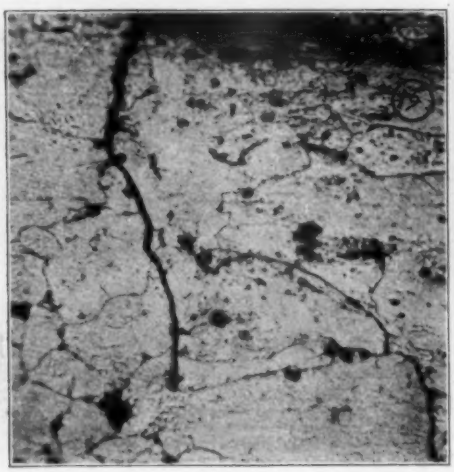


Figure 15.

Figure 16.

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IMPORTANT:

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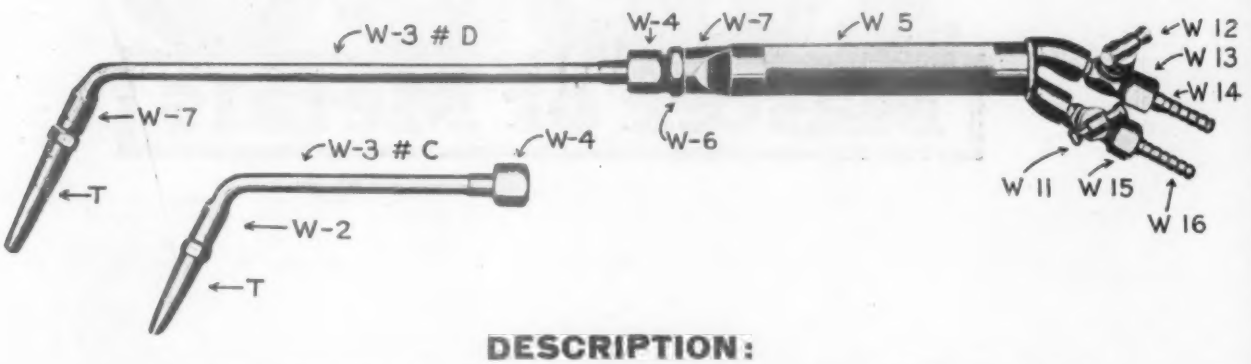
■ ■ ■ ■

STANDARD WELDING TORCH

STYLE W



DESCRIPTION:

THE CONSTRUCTION OF OUR WELDING TORCH IS SHOWN IN LINE CUT. A VERY CAREFULLY DESIGNED MIXING CHAMBER (W6) MIXES THE OXYGEN COMING THROUGH THE CENTER HOLE INTO WHICH THE ACETYLENE IS SPRAYED IN THROUGH A NUMBER OF FINE SIDE HOLES THUS PRODUCING A PERFECT MIXTURE.

HANDLE (W5) IS SCREWED ONTO THE TORCH BASE AND CAN EASILY BE REMOVED BY LOOSENING A SET SCREW. FOUR LARGE VENT HOLES ARE DRILLED THROUGH THE BASE AND THE MIXING CHAMBER CASTING SO AS TO PROCURE A PERFECT VENTILATION. THE THREAD FOR ACETYLENE IS ¼" PIPE AND FOR THE OXYGEN INLET ⅜" PIPE, SO THAT THE HOSE CANNOT BE CONNECTED WRONG.

THE MIXING CHAMBER (W6) IS FAR REMOVED FROM THE TIP END OR HEAT ZONE. THE UNMIXED ACETYLENE, THEREFORE, CANNOT GET OVERHEATED AND CAUSE FLASH-BACKS THROUGH DECOMPOSING, NOR CAN IT GET SO HOT AS TO VARY IN EXPANSION AND CAUSE FLUCTUATIONS OF THE MIXTURE, THUS CHANGING THE CHARACTER OF THE FLAME. THE FLAME ONCE SET NEUTRAL WILL STAY NEUTRAL REGARDLESS OF THE VARYING HEAT AT THE TIP END AND WILL NOT FLASH.

THE STANDARD WELDING TORCH IS SOLD WITH TWO EXTENSIONS (W3-C AND W3-D) SO AS TO HAVE EITHER A 16" LONG TORCH OR A 22" LONG ONE, GIVING YOU PRACTICALLY TWO TORCHES OF DIFFERENT LENGTHS. A THIRD EXTENSION (W3-F) MAY BE SUPPLIED SO AS TO MAKE THE TORCH 30" OVER ALL. NINE INTERCHANGEABLE TIPS (T1-T9) GO WITH EACH TORCH.

The Weld's the Thing

Forget the Torch,
if it's a REGO

For WELDING and CUTTING

REGO

Master of Metals

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MANY a weld takes all the skill in a man's fingers and all the brains in his head. When he is welding a broken aluminum crank case, for instance—what he wants to concentrate on is the heat-diffusion, alignment, temperature of his metal, the oxide, and so on—*the weld itself!*

He wants to *forget the torch*, as a sculptor forgets his chisel!

Before the REGO was perfected, this was impossible. Simply because, very often, the torch required nearly as much attention as the weld itself—to the detriment of the welding art.

Now you can forget the torch when you weld with a REGO.

The explanation: the REGO flame is made by oxygen and acetylene, mixed in the tip, under *low, balanced pressure.*

The REGO flame is neutral, smooth, steady—it will not flash back. Plunge the REGO tip into molten metal, press it tight against fire-brick—still it will not flash. The one torch for close quarters! It will not oxidize, carbonize, or blow the metal.

When you weld with a REGO, you can put your whole thought and skill on the weld itself—you can forget the torch.

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"A New Principle in Welding and Cutting Apparatus."
It tells the story in detail. Catalog also upon request.

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It is not my intention to tell you how to make good welds, but it may be well to state that there seems to be quite a definite relation between the thickness of metal, the size of tip and the size of the welding wire, in the case of gas welding, and between the thickness of metal, the diameter of the electrode, and the current used, in electric welding. It is also to be understood that electric welds, except possibly those made with covered electrodes, will not stand as much bending as O. A. welds.

which were not visible, and which have usually been very small at the start. During the war, when the demand for gun steel was very heavy, flaky steel, so called, was the material that gave the Government the greatest cause for concern. In fact, those who are best posted on the metallurgy of steel are paying more and more attention to the minor defects, which heretofore have been considered but of little importance. This is equally true in a case of welds and in finding out what a welder can do,

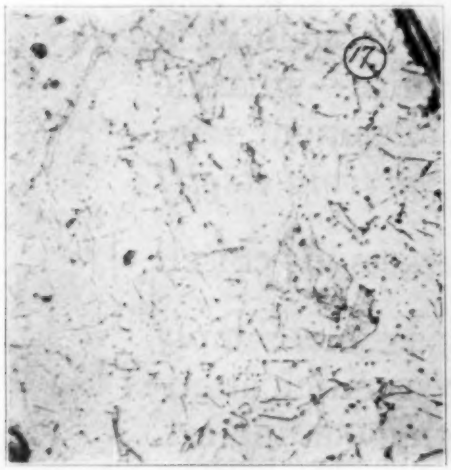


Figure 17.

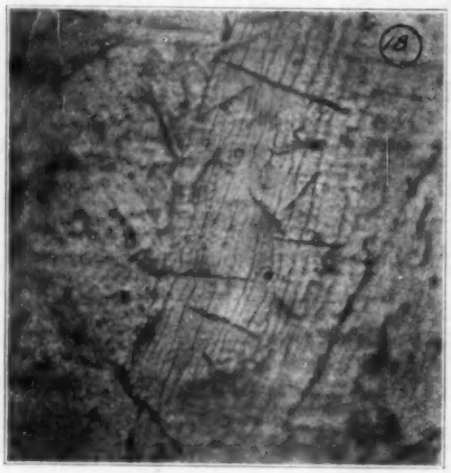


Figure 18.

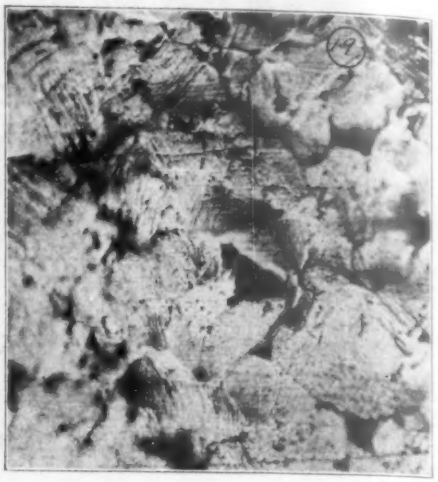


Figure 19.

Fig. 17. Arc weld made probably with too long an arc, as there should not be so much iron nitride.

Fig. 18. Slip bands in arc weld. The heavier straight lines are iron nitride. These weaken the weld little, if any, because the slip bands usually stop at them, as at grain boundaries.

Fig. 19. Good part of arc weld heated red hot and slowly cooled. Distortion is by slipping as in normal steel. Large dark spot in center is iron nitride.

Figure 20.

Fig. 20. Metallic arc weld heated red hot and quenched. No appearance of defects.

Fig. 21. Same weld as No. 20. There was no defect visible before strain. Ruptures are intergranular.

Fig. 22. Another view in weld No. 20. Ruptures are partly at a globule, the unbroken oxide film showing at the bottom, and partly where no defects showed.

Fig. 23. Large defect in arc weld. Dark streak is oxide of iron.

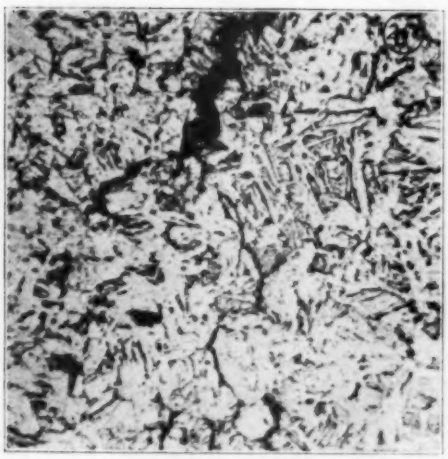


Figure 21.

Figure 22.

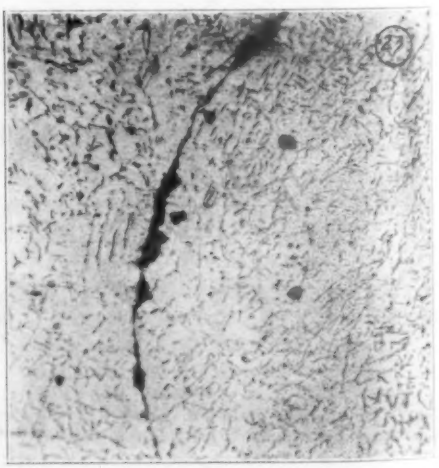
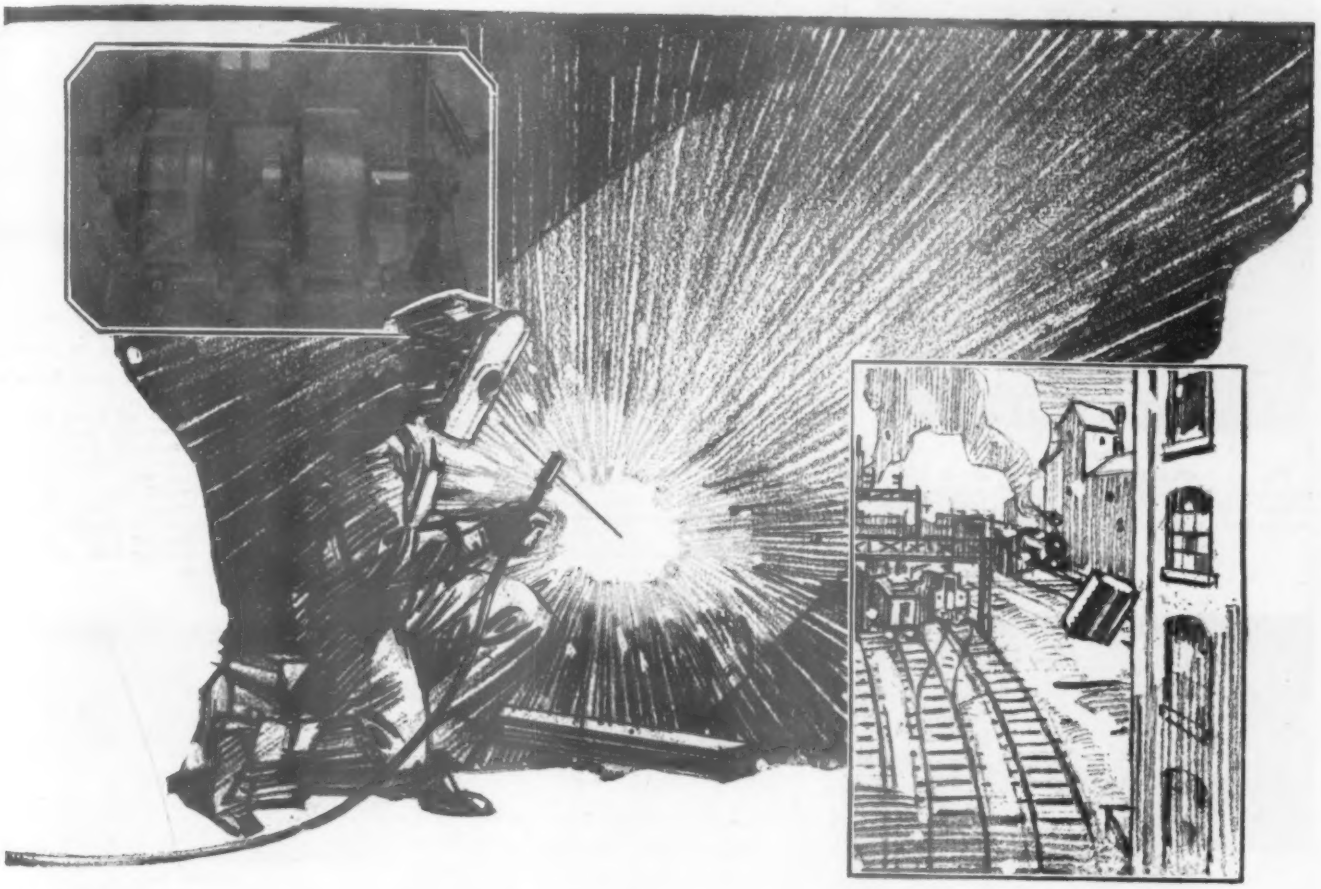


Figure 23.

In many cases, the defects in welds are easily visible to the naked eye when tested. In other cases, they are not, and while it would seem plausible that the visible ones were more dangerous, yet to my mind, the hidden danger due to the ones that are hard to see is a matter that must not be overlooked. For many years, the dangerous defects in steel rails have been those

this is one of the things that should be examined most carefully. There has recently been developed a method for testing rails for these hidden defects which has been devised by Mr. A. M. Waring. It consists of deeply etching a polished surface of the material under test. For instance, a section of a weld might be cut out with a hack saw, machined or filed to a true surface,

Sometimes the producer is so absorbed with the task of producing, that he overlooks means which might make his plant more productive



A Welded Seam with All the Strength of the Original Metal

Full of oil and sealed tight a tank was dropped from a four-story building onto a railroad track, and nothing but a dent in the tank! A real test of strength, and yet the electric arc welded seam did not leak or show a sign of weakness. Electric welding makes every seam a part of the product itself, rather than a connection which merely holds it together.

In every industry wherever metals are joined together, the electric weld is stronger, more durable, and permits special construction and more efficient design of parts than is possible with bolts and rivets. Its uses are so varied that in places where it is installed for a certain purpose, it soon develops a greater usefulness as men become more familiar with its operation.

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and polished on various grades of emory paper, ending up with 00 Manning. It is then placed in a warm solution of 25 per cent hydrochloric acid and water for from a half an hour to an hour. The acid will eat away the defects, making the edges of the material at them taper, so that rather large grooves and pits will be visible where the defects prior to the etching would be only microscopic. It is not really necessary to warm the acid altho it takes longer when it is cold. The bending test hot and cold, and the etching test, I consider to be of the greatest value in ordinary shop practice where it is desired to find out rapidly and quite accurately what the quality of the work done by the different welders is.

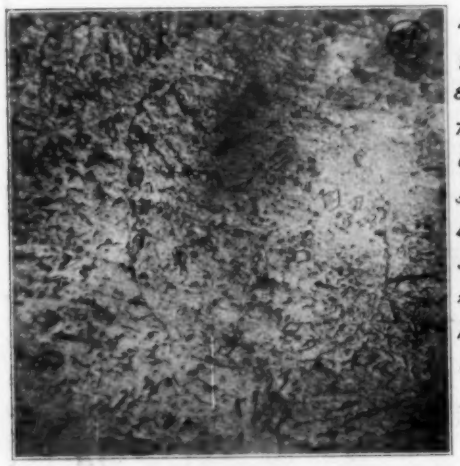


Figure 24.

Fig. 24. Globule in arc weld about 1/300" diameter, surrounded by film of oxide about 1/8000" thick. This is a weak spot in the weld, and such spots give first under strain.

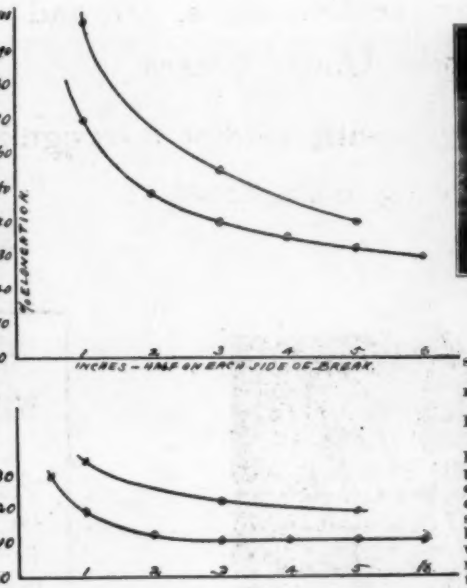


Figure 25.

Fig. 25. The uppercurves show the difference in elongations of two pieces of steel of the same tensile strength. The upper curve shows the more ductile piece. The lower curves show the elongations measured the same way, of welded test pieces of the same materials, the upper curve being in the more ductile material. So it is necessary to know all about the materials being welded before comparisons of welds can be fairly made.

Figure 26a.

Fig. 26A. Oxy-acetylene weld in .50 C shell steel made with Roebling o-a wire.
Fig. 26B. Oxy-acetylene weld in shell steel made with shell steel.
Fig. 26C. Arc weld in shell steel made with Roebling electric wire.

Fig. 26, A, B, and C. In all cases the black line shows the original surface, and the white parts contain very little carbon. The heat effect extends to D in each case. The decarbonization of the original material and the change in structure, even if the weld were sound, would be a defect in some cases. Note that even where .50 C steel is used for welding, there is not much carbon left in the weld. Also that the loss of carbon is greater with arc welding than with oxy-acetylene.

Figure 26b.

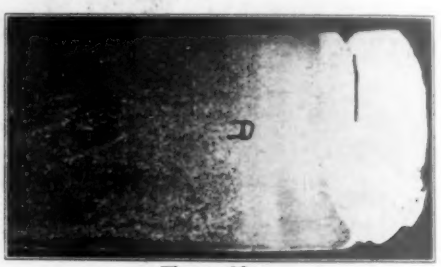


Figure 26c.

Some of the defects in welds are visible under the microscope but others are not visible until the weld is strained. A small bending machine that can be placed on the microscope stage is very useful, because after etching the piece can be bent and examined and see what the effect of the strain is. In the case of bare wire electric welds, the rupture, as far, as my experience goes, always occurs at the grain boundaries even where no defects are visible there at the highest powers of the microscope. Of course, where there are visible defects, the rupture takes place first at these. Where there are not defects, the distortion occurs by slipping in the grains as in normal steel. The causes of these defects are to my mind almost always oxides of one or another constituent of the metal, but usually of iron. There is no positive proof of this as yet but there are indirect proofs. An electric weld that will bend very little may be made much more ductile by heating in a reducing atmosphere at a low red heat for one or two hours indicating that the weakness at the grain boundaries has been removed. The reducing atmosphere would seem to make it clear that the material at the grain boundaries was on oxide. Again, heating an electric weld in an oxidizing atmosphere makes it more brittle. The same treatment affects O. A. welds in the same way but in as much as they are normally not as brittle as electric welds, the improvement is not so noticeable.

These rough tests, while satisfactory for determining the general quality of the work, do not answer as a basis for design and more refined tests must be used as before referred to. I believe that the most important of these are the tensile and alternating stress tests. The tensile test can be made in any shop provided with the usual tensile testing machine. The alternating stress test is not as yet standardized even for unwelded material. I am inclined to believe that the machine devised by the Quasi-Arc Company is of considerable value although it does not give absolute results, that is, it does not give the amount of fibre stress to which the piece is subjected. During the war, the electric welding committee of the Emergency Fleet Corp. designed and built a machine for testing welds up to ¾-inch thick and 8-inch wide in which the fibre stress could be measured. The idea being to test large sections of welds. This machine has not yet been used. The ordinary machine for determining the resistance to alternating stress uses a rather small test piece about ⅜ by 2 inches in section which is vibrated back and forth at about a one-thousand alternations per minute. Another machine that will give considerable information is that designed by Mr. F. M. Farmer of the Electrical Testing Laboratories in New York. The test piece is round and is rotated under load. In both these latter cases, the fibre stress can be accurately determined, and this being known, the number of alternations or revolutions is the measure of the resistance of the piece. The difficulty with these two methods of tests is that the pieces are very small so that a small defect may cause the piece to break long before a larger piece would, or before a full sized weld would show any evidence of strain.

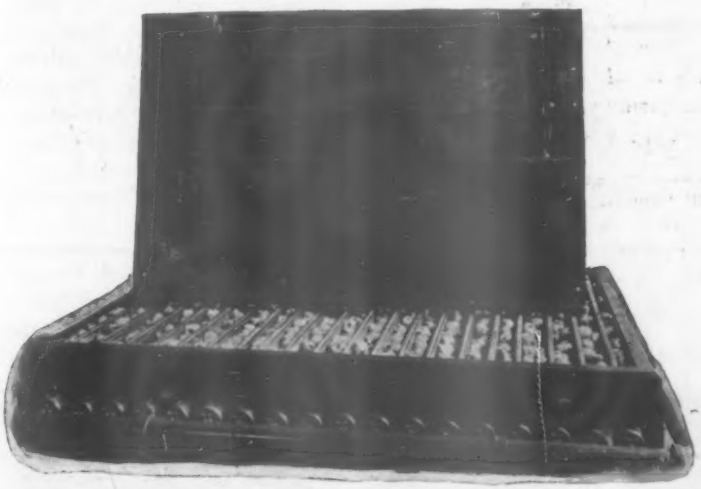
A great deal may be learned from the appearance of a weld. It is difficult to describe the appearance of good welds but after they have been seen a number of times, an inspector can readily say whether the operator knows what he is doing. In gas weld-

WIEDERWAX PREHEATER

For Preheating All Kinds of Castings

It is in use in modern welding shops, railroad repair shops, foundries and factories all over the United States.

Its value in conjunction with welding is recognized and admitted by the best authorities on welding in the country.



This casting, four feet wide and six feet long, varying in thickness from two to five inches, was preheated and cooled on a WIEDERWAX Preheater. Same was laid flat on the Preheater and covered with sheet metal. The job came out perfect as all similar kinds do when the WIEDERWAX is used. Note the cracks in the casting before it was welded.

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Properly preheats castings with large, flat surfaces that are difficult to handle by either charcoal or torches.

Eliminates any danger of cracking or warping.

Does away with hard spots that give trouble when casting is to be machined.

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ing, I would not accept a ripple weld in heavy material nor one which was narrower than about 2½ times the thickness of the sheet, because I have never seen a weld having these appearances that was properly welded. The appearance of properly made electric welds has been well described by Mr. Escholtz of the Westinghouse Company and has been published in several of the trade journals. The appearance in a gas weld of porosities on top, indicates that the metal has been overheated, and the same thing is true in an electric weld. Inasmuch as I believe that the serious defects in welds are caused by oxides, it would appear wise in the case of gas welding to use no larger tip than is necessary to produce thorough fusion. This means that the catalogue speeds of welding are impossible if good welds are desired. The same thing is true of electric welds. The reason is that at the high temperatures of the steel caused by too large a tip or too heavy a current, the metal becomes overheated, and in that condition combines more readily with the oxygen of the air or with any excess oxygen in the torch flame, and produces oxides which are readily dissolved by the melted metal. As the metal cools down, these oxides are rejected in large part and pass to the grain boundaries, as do other impurities, so that it is perfectly natural that material which has been seriously overheated should be more brittle and weaker than the material which has been properly melted. In conclusion, I have found in a number of cases that very great improvements in the quality of the work were made by using regularly the bending test above described and by carefully instructing the welders until they were able to make welds that would meet this test with unfailing regularity.

ANCIENT MARINER A LA 1920

Among the many thousands of visitors to the Marine Exposition held April 12 to 17 at the Grand Central Palace, New York, one was readily able to identify the "salt water" men, the practical men of the sea. The one sure mark of the practical sailorman was his interest in things rather than principles and processes entering into their production. One evening a typical "old salt" of the shiver-my-timbers variety warped his way into the booth of the Oxweld Acetylene Company. So far as he was concerned the interesting, eye-catching exhibit of brightly polished welding and cutting torches and the imposing array of Linde oxygen and Prest-O-Lite acetylene cylinders, lined up like troops on dress parade, were only a setting for the real show. The things that attracted and held his interest were the specimens of welded ventilator cowls, desk collars, stanchions, etc., which stood out boldly in the foreground like so many old friends eager to greet him. But there was something strange about them too, as if they had been tricked out for the occasion. It was welding.

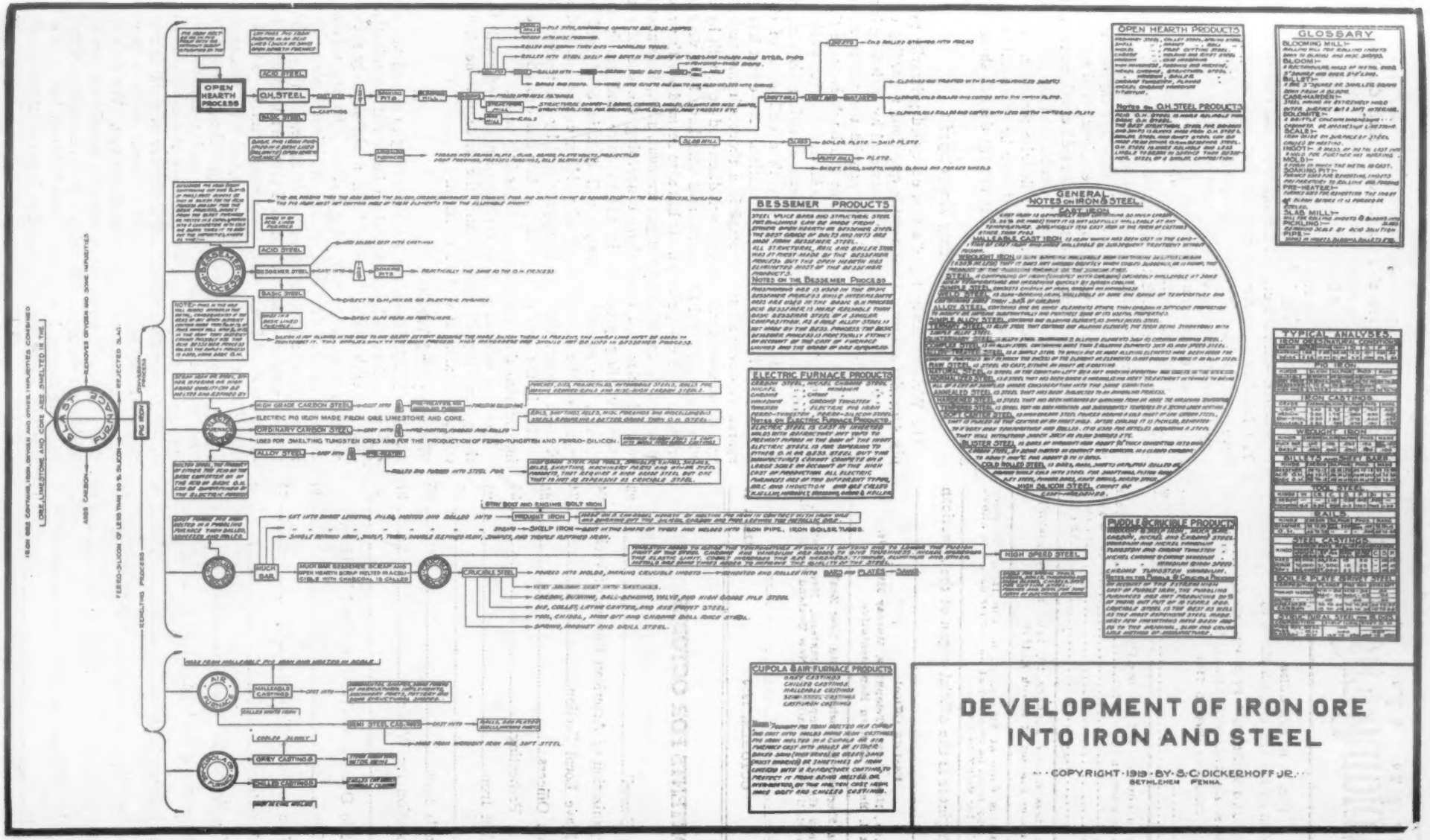
The Ancient Mariner a la 1920 regarded them critically, almost disapprovingly, as one who might ask, "Who told you you could dress up?" As they deigned no reply, the old fellow ran his hands over the smooth welds, feeling of them speculatively, appraisingly, testingly. At length he seemed satisfied. "They ought to be all right," he pronounced at last. "They look strong and they are strong. Tight as a hatch. And there ain't any rivets to pick up rust!" He had spotted at a glance the practical advantages of welding work that is making it a specification in practically all new construction wherever welding is permitted.

A THERMIT WELDED WHEEL PRESS

These two illustrations show a successful thermit weld recently made at the Bogalusa, La., shops of the Louisiana Great Northern Railroad. This weld was made while the press was in position as shown, opposite a similar weld which was made five five years ago and which has stood the strain all these years. The weld shown is thirty inches long and three inches thick.

Wheel Press Repair, Showing Break.

Wheel Press Repair, After Welding



A CHART OF USEFUL INFORMATION FOR WELDERS

A wealth of information regarding iron and steel and their development from the ore is contained in this little chart. It tells the story of production at a glance and lists the products of the various processes. At the right is a glossary and a table of typical analyses. Blue prints of the chart, thirty inches by fifty inches can be obtained from the designer, S. C. Dickerhoff, Jr., Bethlehem, Pa., for $1.50, or black and white prints on heavy white paper for $1.00.

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VOLUME 5. OCTOBER, 1920 NUMBER 10

CONTENTS FOR OCTOBER

National Research Council..... 23
Proposed New Organization of American Bureau of Welding 24
New Yorkers to Have Local Section..... 24
Philadelphia Section Officers..... 25
Chicagoans Discuss Preheating..... 25
The Brazing of Cast Iron..... 25
Testing Welds 26
Ancient Mariner a la 1920..... 36
A Chart of Information for Welders..... 37
Editorial 38
A New Street in Our Town—Wanted—Good Welders.
Special Butt Welders..... 40
Welding Flue Points to Boiler Tubes..... 44
The Village Blacksmith..... 46
Welding Locomotive Frames..... 48
Oxy-Acetylene Makes $13,00 Saving..... 48
The Oxy-Acetylene Industry in Cuba..... 50
Arc Welding for Foundries..... 52
New Preheating Furnace..... 54
Current Welding Literature..... 56
Welding News 56

Another Street in Our Town.

STREETS are avenues of communication. By means of them, people are able to travel to their destination. In olden days folks depended upon cross-lot trails—the means of communication being both tortuous and uncertain.

Until the establishment of *The Welding Engineer*, in January, 1916, the welding industry was without an avenue of communication—and the cross-lot trails were few and far between. *The Welding Engineer* has changed that condition and we believe that to its fair, clean and progressive editorial policy may be traced many of the improvements and much of the progress of the welding industry.

In the past few years "our town" has grown and expanded to the point where it is today quite a city. In fact, the art of autogenous welding has come to be a most important branch of mechanics. This growth has been a healthy one and has been brought about wholly by the efficiency and economy of the various welding processes. This rapid development of the art of autogenous welding has brought into use hundreds of words and terms of obscure or indefinite meaning. To read welding literature intelligently will soon be impossible without the use of a reference book that clearly defines these words and terms.

The Welding Encyclopedia

The Welding Encyclopedia was compiled primarily to supply such definitions. Innumerable questions regarding equipment and accessories have been answered by including in this text a complete list of trade names with the names and addresses of the manufacturers. But the book is more than a glossary, for it contains up to date instructions for welding all standard metals by the oxy-acetylene, electric resistance, electric arc, and thermit processes, with a collection of charts and tables of much needed information. No effort has been spared to cover all this ground in a thorough and authoritative manner—special subjects are discussed at length by men who are recognized as experts and who have been very generous in their co-operation. It has also seemed worth while to include a compilation of the government, state, insurance and railroad rules and regulations concerning the use of autogenous welding processes in manufacture and repair work. Finally, the advertising pages will contain condensed catalogues of the various types of welding equipment and supplies—a feature that will be appreciated by the reader.

This is the first attempt to put between two covers *all* the information that a welder could possibly want.

The first edition of The Welding Encyclopedia will be off the press early in January and the price will be $5.00 per copy, postpaid. It will be worth it.

Wanted—Good Welders.

ALTHOUGH there are signs pointing to a tendency on the part of some large American industrial organizations to dispense with the services of labor not absolutely necessary, we do not know of any *good* welders who are walking the streets. In fact, this issue of *The Welding Engineer* carries a request, from a well known manufacturer, for fifty good electric arc welders—and we doubt if they are available. Such a condition should be a source of encouragement to the apprentice. There is good work and plenty of it for him as soon as he is prepared to handle it. But he must bear in mind that this trade cannot be mastered on short notice, that the men who speak with the greatest authority are the most ready to admit their own limitations. An instructor of welding remarked the other day that it was hard to enroll students in welding schools because of the low starting wage. We do not think that the trade has lost many valuable recruits on this account. Welding is not a get-rich-quick scheme, especially since porch-climbing tactics have grown into disfavor, but it is a lucrative and honorable trade—and it is growing more important

Like Mahomet and the Mountain

IT was lots easier to bring Prest-O-Lite and the oxy-acetylene flame to this mammoth wheel than to haul the wheel five miles from a mountain mine to a repair shop.

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and higher in industrial favor every day. Stick a pin in that. We do not believe in profiteering on the customer nor in misrepresenting to the beginner. We do earnestly believe in encouraging the novice and giving him every possible help toward perfecting himself in his art. It is the only logical way, the only sane way, to get him on the road to a growing income. The welding industry needs men who are ambitious to become master welders, and is prepared to pay them well as soon as they can produce.

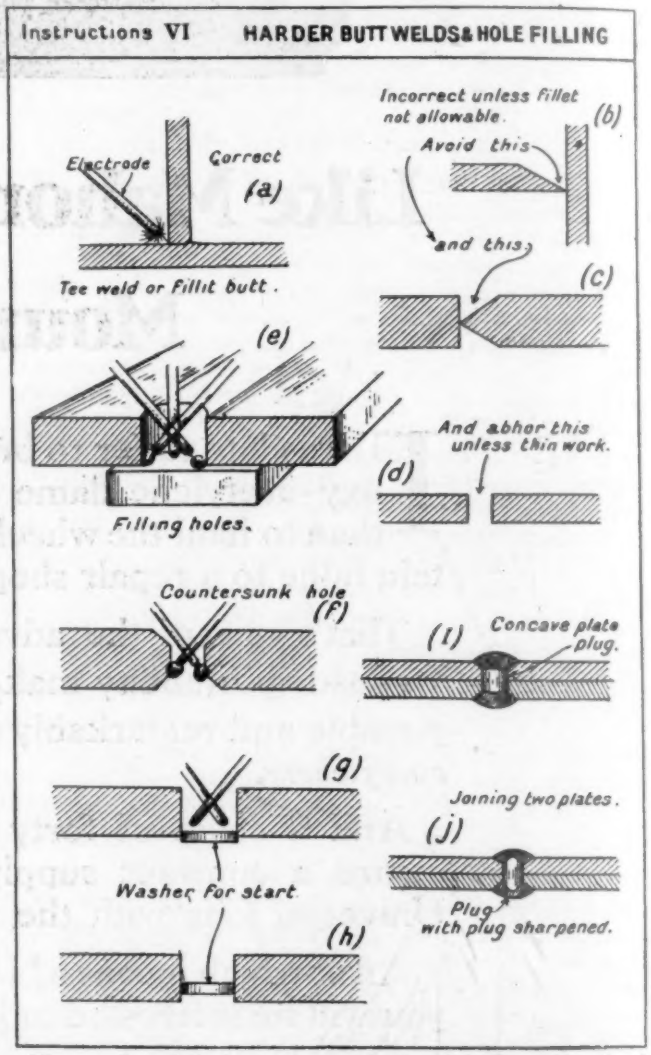
SPECIAL BUTT WELDS*

Figure A shows a "T" weld in which a full fillet is used on each side for strength and where a single bead is run to start the weld and assist the laying of the final layers as by spreading, as outlined in Figure E, Instruction 6. There are many advocates of a "T" joint, as shown by the single bevel on the vertical plate of Figure B, but it entails a hardship on the operator's reputation as it is practically impossible to make a good job. The horizontal joint of this type either single bevel, singe "V," as shown by the horizontal plate in Figure B, or double bevel, single "V," as shown in Figure C, is easier to accomplish, but still so hard that it is better to avoid wherever possible.

The vertical type of this weld is almost impossible as described, and although metal may be put into the space of the "V," and a good weld may result after "V" space has been filled flush and the fillet started, yet a great deal of perfectly good metal has been unecessarily cut away and filled in with metal which stands a more than even chance of being burned due to not being welded with a good chance of ruining the full fillet which might have been obtained as in Figure A. Welds can be made as shown in Figure C, and have to be done where there is no chance but to "V" out but one side, for instance, a weld on a part not protruding sufficiently to "V" it. The angle on the piece that is machined must be much greater, so that the electrode can be kept approximately at right angles to the face. In welding, plates not veed of shape, as shown in Figure D, is almost impossible unless the work is thin as shown in Instruction 2, or unless the pieces are separated an extraordinary amount and access is had to both sides. A weld like this is possible, however, but should be avoided due to the care necessary and slow speed and chance of failure resulting.

This leads us to hole-filling and in general a large hole is easier to fill than a small one, especially on thick work, because of the ease with which the electrode can be pointed at an angle approximately at right angles to the vertical face, which is the face on which care must be taken to insure the first bead of each layer welding, and not more than one bead on the vertical face should be made ahead of filling in the horizontal remainder of that layer so that the danger of the molten metal running down and filling the centre of the hole without welding is a minimum. In general the procedure is to back up the bottom of the weld as in Figure E by a backing plate, or as in Figure G, with a washer or burr, or as in Figure H, with the washer or burr in the center. Countersinking from one or both sides, as in Figure F, is highly desirable, and for medium-sized holes and relatively thick plates is absolutely necessary to allow for the electrode to reach in at right angles to the vertical face. This countersinking also makes a vertical rivet out of the weld with two heads, although padding on a straight hole will accomplish the same purpose, but the padding is generally removed where a hole is to be filled, especially for subsequent redrilling, and with the countersinking method the resulting action still exists after machining although for subsequent redrilling even though slightly off center, i. e., drilling through the weld and original metal, if a good weld is not made with the vertical face this partially off-center drilling will show it up by the weld being pushed out ahead of the drill, as soon as the top rivet head of the weld has been cut away.

The method in filling a hole used by the best welders is to start at the bottom of hole from both sides, and work successively in a circle on the vertical face for two beads, then fill in to the level of the first bead and always keep one bead in advance on the vertical face, filling in the remainder of the hole. Testing of holes filled in this manner by blows of unregistered strength against the welded portion only may result in the weld being driven out like a beheaded rivet, but this is not indicative necessarily of a poor weld, as the weld is entirely different in physical characteristics and the line of demarcation especially in hole filling is well defined. The proper way to test this is by registered static strain comparing the results to the sheer strength of similar metal of the original plate.



Figures I and J show two methods of using a plug in the center to both fill up a hole such as a rivet or bolt hole, and to draw the plates together by putting a head on the end of the plug. Figure I shows the plates countersunk, and figure J the plug tapered. Figure I is by far the better way, although a combination of the two might be used as the angle is wider and hence of easier access.

In filling up "blow holes," in castings, porous and sandy spots must be chipped out or cleaned out by the electric arc by using the cutting tap with which each of our casing filler machines are equipped. This is to enable the operator to obtain real metal as a foundation for the weld and to open up the hole so that no recesses or narrow vertical faces exist.

Instruction No. 6 from the handbook of the Electric Arc Cutting & Welding Co., 222 Halsey Street, Newark, N. J. Copies of the complete instruction book may be had from this company at $1.25 each.

Steel Vaporized in the Arc

And Exposed to the Air becomes oxidized and chilled.

Consequently the weld is often brittle and porous.

It may hold under strain—and it may not.

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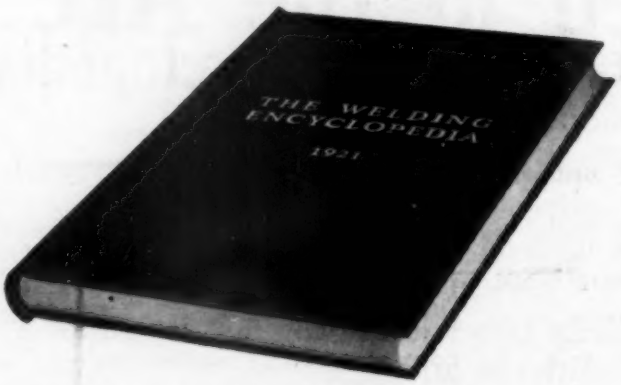


The Publisher of The Welding Engineer begs to announce the forthcoming publication of America's latest and most complete text book and Dictionary on the subject of Autogenous Welding.

The Welding Encyclopedia

Edited By L. B. Mackenzie, Editor and Publisher of The Welding Engineer, Chicago.

The Welding Encyclopedia, as its name would imply, will cover the subject of Autogenous Welding as no other publication, or group of publications, has ever covered it. It deals with every phase of the art of Autogenous Welding, as we know it today, and contains a mass of useful information needed in every welding shop.

Partial Contents

1. A complete Dictionary of all of the terms used in welding, with thorough explanations, illustrations, etc. This section alone comprises the most complete text book on the subject of welding we know of.

2. The Trade Names of all welding apparatus, supplies, equipment and devices used by welders, including an explanation of purposes for which used and the maker's name and address.

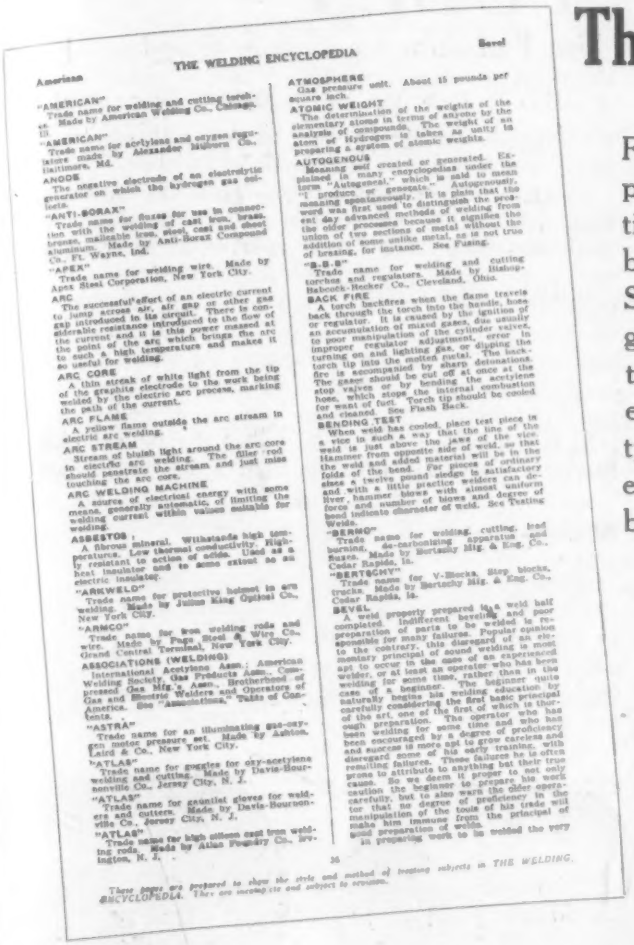
3. How to weld Iron and Steel, Cast Iron, Aluminum and all other weldable metals. Each metal is treated separately and the various processes, such as the Electric Arc, Oxy-Acetylene and Thermit processes, are treated individually. Just the sort of a book we have always wanted to recommend to our friends.

4. All about the laws and regulations relating to Autogenous Welding, Government Laws, Ocean and Coastwise, Rivers and Great Lakes, State and City Laws and the rules and regulations of the Insurance companies and their Inspection Bureaus; rules of the American Railway Association (M. C. B.), which tell you what you can weld on cars and locomotives, and also the rules of the Boiler Code Committee of The American Society of Mechanical Engineers. (These rules practically govern the welding of fired and unfired pressure vessels in America.)

5. Tables and charts of information about things the welder usually has to guess at. Melting points of metals, charts of Temperature Colors. In fact the Encyclopedia contains a fund of information every welder will appreciate and find useful.

6. Last, but highly important, The Welding Encyclopedia will contain a mine of interesting information about American made welding and cutting apparatus, supplies and equipment, as used by American welders. The announcements of the leading manufacturers constitute a most complete catalog — something welders will value.

Typical Pages in The Welding Encyclopedia



THE WELDING ENCYCLOPEDIA

"AMERICAN"
Trade name for welding and cutting torches. Made by American Welding Co., Chicago, Ill.

"AMERICAN"
Trade name for acetylene and oxygen regulators made by Alexander Milburn Co., Baltimore, Md.

ANODE
The negative electrode of an electrolytic generator on which the hydrogen gas collects.

"ANTI-BORAX"
Trade name for fluxes for use in connection with the welding of cast iron, brass, bronze, malleable iron, steel, cast and sheet aluminum. Made by Anti-Borax Compound Co., Ft. Wayne, Ind.

"APEX"
Trade name for welding wire. Made by Apex Steel Corporation, New York City.

ARC
The successful effort of an electric current to jump across air, air gap or other gas gap introduced in the circuit. There is considerable resistance introduced to the flow of the current and it is this power released at the point of the arc which brings the arc to such a high temperature and makes it so useful for welding.

ARC CORE
A thin streak of white light from the tip of the graphite electrode to the work being welded by the electric arc process, marking the path of the current.

ARC FLAME
A yellow flame outside the arc stream in electric arc welding.

ARC STREAM
Stream of bluish light around the arc core in electric arc welding. The filler rod should penetrate the stream and just miss touching the arc core.

ARC WELDING MACHINE
A source of electrical energy with some means, generally automatic, of limiting the welding current within values suitable for welding.

ASBESTOS:
A fibrous mineral. Withstands high temperatures. Low thermal conductivity. Highly resistant to action of acids. Used as a heat insulator and to some extent as an electric insulator.

"ARKWELD"
Trade name for protective helmet in arc welding. Made by Julius King Optical Co., New York City.

"ARMCO"
Trade name for iron welding rods and wire. Made by Page Steel & Wire Co., Grand Central Terminal, New York City.

ASSOCIATIONS (WELDING)
International Acetylene Assn.; American Welding Society, Gas Products Assn., Compressed Gas Mfg.'s Assn., Brotherhood of Gas and Electric Welders and Operators of America. See "Associations," Table of Contents.

"ASTRA"
Trade name for an illuminating gas-oxygen motor pressure set. Made by Ashton, Laird & Co., New York City.

"ATLAS"
Trade name for goggles for oxy-acetylene welding and cutting. Made by Davis-Bournonville Co., Jersey City, N. J.

"ATLAS"
Trade name for gauntlet gloves for welders and cutters. Made by Davis-Bournonville Co., Jersey City, N. J.

"ATLAS"
Trade name for high silicon cast iron welding rods. Made by Atlas Foundry Co., Irvington, N. J.

ATMOSPHERE
One pressure unit. About 15 pounds per square inch.

ATOMIC WEIGHT
The determination of the weights of the elementary atoms in terms of anyone by the analysis of compounds. The weight of an atom of Hydrogen is taken as unity in preparing a system of atomic weights.

AUTOGENOUS
Meaning self created or generated. Explained in many encyclopedias under the term "Autogeneal," which is said to mean "I produce or generate." Autogenously, meaning spontaneously. It is plain that the word was first used to distinguish the present day advanced methods of welding from the older processes because it signifies the union of two sections of metal without the addition of some unlike metal, as is not true of brazing, for instance. See Fusing.

"B-B-B"
Trade name for welding and cutting torches and regulators. Made by Bishop-Babcock-Becker Co., Cleveland, Ohio.

BACK FIRE
A torch backfires when the flame travels back through the torch into the handle, hose or regulator. It is caused by the ignition of an accumulation of mixed gases, due usually to poor manipulation of the cylinder valves, improper regulator adjustment, error in turning on and lighting gas, or dipping the torch tip into the melted metal. The backfire is accompanied by sharp detonations. The gases should be cut off at once at the stop valves or by bending the acetylene hose, which stops the internal combustion for want of fuel. Torch tip should be cooled and cleaned. See Flash Back.

BENDING TEST
When weld has cooled, place test piece in a vise in such a way that the line of the weld is just above the jaws of the vise. Hammer from opposite side of weld, so that the weld and added material will be in the folds of the bend. For pieces of ordinary size a twelve pound sledge is satisfactory, and also a little practice welders can develop with almost uniform blows with almost uniform force and number of blows and degree of bend indicate character of weld. See Testing Welds.

"BERNO"
Trade name for welding, cutting, lead burning, de-carbonizing apparatus and fuzes. Made by Berturchy Mfg. & Eng. Co., Cedar Rapids, Ia.

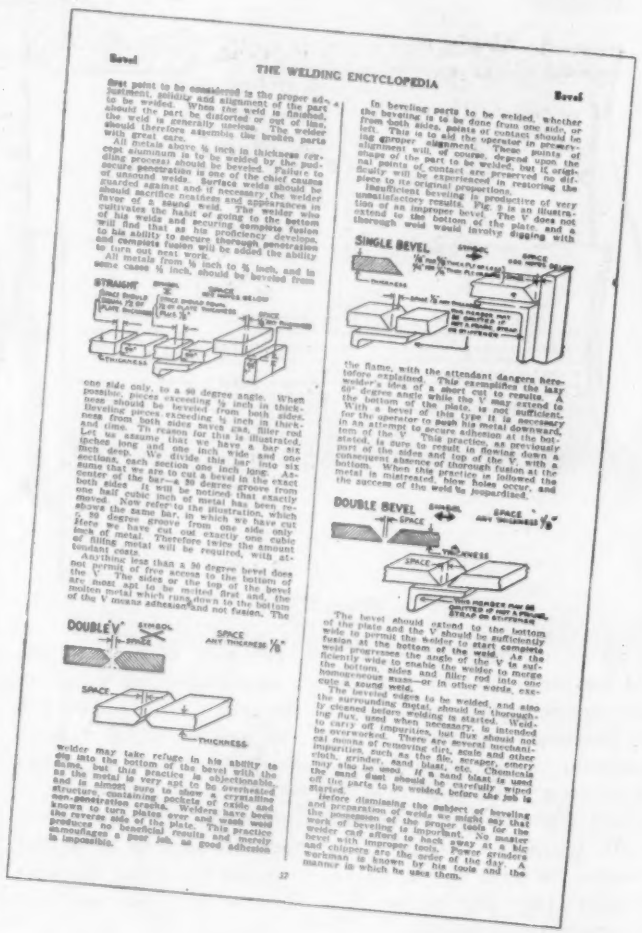
"BERTSCHY"
Trade name for V-Blocks, Step blocks, trucks. Made by Bertschy Mfg. & Eng. Co., Cedar Rapids, Ia.

BEVEL.
A weld properly prepared has a weld half completed. Indifferent bevelling and poor preparation of parts to be welded is responsible for many failures. Popular opinion to the contrary, this disregard of an elementary principal of sound welding is most apt to occur in the case of an experienced welder, or at least an operator who has been welding for some time, rather than in the case of a beginner. The beginner quite naturally begins his welding education by carefully considering the first basic principal of the art, one of the first of which is thorough preparation. The operator who has been welding for some time and who has been encouraged by a degree of proficiency and success to grow careless and disregard some of his early training, with resulting failures. These failures he is often prone to attribute to anything but their true cause. So we deem it proper to not only caution the beginner to prepare his work carefully, but to also warn the older operator that no degree of proficiency in the manipulation of the tools of his trade will make him immune from the principal of good preparation of welds.

In preparing work to be welded the very

These pages are prepared to show the style and method of treating subjects in THE WELDING ENCYCLOPEDIA. They are incomplete and subject to revision.

Finding information in The Welding Encyclopedia is as easy as looking up "Cat" in the dictionary. All words, terms and trade names used by the welding craft are arranged alphabetically. Special articles on methods, rules, etc., are grouped and conveniently cross-indexed. The two sample pages shown here will illustrate this easy reference idea, and show the style of the type page. With this book in his shop the welder can instantly lay his finger upon any desired bit of welding information.



Bevel THE WELDING ENCYCLOPEDIA Bevel

first point to be considered is the proper adjustment, rigidity and alignment of the parts to be welded. When the weld is finished, should the part be distorted or out of line, the weld is generally useless. The welder should therefore assemble the broken parts with great care.

All metals above ⅛ inch in thickness regular aluminum is to be welded, should be beveling pieces should be beveled. Failure to secure penetration is one of the chief causes of unsound welds. Surface welds should be guarded against and if necessary, the welder should sacrifice neatness and appearances in favor of a sound weld. The welder who cultivates the habit of going to the bottom of his welds and securing complete fusion will find that as his proficiency develops, and composite fusion will be added the ability to turn out neat work.

All metals from ⅛ inch to ¾ inch, and in some cases ½ inch, should be beveled from one side only, to a 90 degree angle. When possible, pieces exceeding ½ inch in thickness should be beveled from both sides. Beveling pieces exceeding ½ inch in thickness from both sides saves gas, filler rod and time. To reason for this is illustrated. Let us assume that we have a bar six inches long and one inch wide and one inch deep. We divide this bar into six sections, each section one inch long. Assume that we are to cut a bevel in the exact center of the bar—a 90 degree groove from both sides. It will be noticed that exactly one half cubic inch of metal has been removed. Now refer to the illustration, which shows the same bar, in which we have cut a 90 degree groove from one side only. Here we have cut out exactly one cubic inch of metal. Therefore twice the amount of filling metal will be required, with attendant costs.

Anything less than a 90 degree bevel does not permit of free access to the bottom of the V. The sides or the top of the bevel are most apt to be melted first, and the molten metal which runs down to the bottom of the V means adhesion and not fusion. The welder may take refuge in his ability to dig into the bottom of the bevel with the flame, but this practice is objectionable, as the metal is very apt to be overheated and is almost sure to show a crystalline structure, containing pockets of oxide and non-penetration cracks. Welders have been known to turn plates over and weld from the reverse side of the plate. This practice produces no beneficial results and merely camouflages a poor job, as good adhesion is impossible.

In beveling parts to be welded, whether the beveling is to be done from one side, or from both sides, points of contact should be left. This is to aid the operator in preserving alignment. These points of alignment will, of course, depend upon the shape of the part to be welded, but if originally will be experienced in restoring the piece to its original proportions.

Insufficient beveling is productive of very unsatisfactory results. Fig. 1 is an illustration of an improper bevel. The V does not extend to the bottom of the plate, and a thorough weld would involve digging with the flame, with the attendant dangers heretofore explained. This exemplifies the lazy welder's idea of a short cut to results. A 60° degree angle while the V may extend to the bottom of the plate, is not sufficient. With a bevel of this type it is necessary for the operator to push his metal downward, in an attempt to secure adhesion at the bottom of the V. This practice, as previously stated, is sure to result in flowing down a portion of the sides and top of the V with a consequent absence of thorough fusion at the bottom. When this practice is followed the metal is mistreated, blow holes occur, and the success of the weld is jeopardized.

The bevel should extend to the bottom of the plate and the V should be sufficiently wide to permit the welder to start complete fusion at the bottom of the weld. As the weld progresses the angle of the V is sufficiently wide to enable the welder to merge the bottom, sides and filler rod into one homogeneous mass—or in other words, execute a sound weld.

The beveled edges to be welded, and also the surrounding metal, should be thoroughly cleaned before welding is started. Welding flux, used when necessary, is intended to carry off impurities, but flux should not be overworked. There are several mechanical means of removing dirt, scale and other impurities, such as the file, scraper, emery cloth, grinder, sand blast, etc. Chemicals may also be used. If a sand blast is used the sand dust should be carefully wiped off the parts to be welded, before the job is started.

Before dismissing the subject of beveling and preparation of welds we might say that the possession of the proper tools for the work of beveling is important. No master welder can afford to hack away at a bad bevel with improper tools. Power grinders and chippers are the order of the day. A workman is known by his tools and the manner in which he uses them.

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WELDING FLUE POINTS to BOILER TUBES

By Charles W. Geiger

MR. CHARLES S. COLEMAN, a fireman in the employ of the Santa Fe Railroad Company, has perfected a new method of welding flue points to locomotive boiler tubes that is a great improvement over the usual method of welding.

Figure 1 shows the old method of welding a flue point and Figure 2 shows the Coleman method of welding the flue point.

There are also two illustrations which represent demonstrations made to show the superiority of the Coleman method of applying flue points to the old tubing, after it has been removed from the boiler and cleaned and made ready to put back in service. Figure 3 is the old style weld which was broken by a pull of 9,200 pounds. Figure 4 is the Coleman way and broke under a pull of 52,300 pounds, and did not part in the weld,

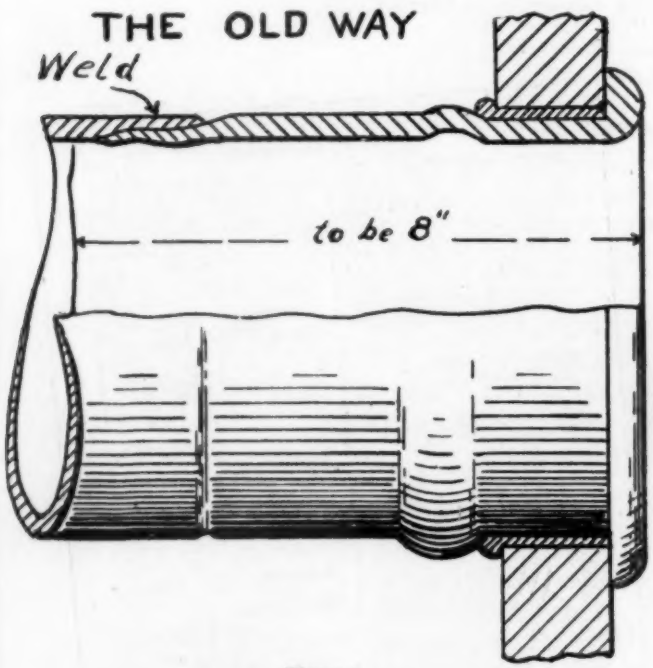


Figure 1.

but pulled the steel tubing in two, one inch from where the weld was made. It did not in the least injure the weld, but broke outside of the heavy part of the tube. This method will save thousands of dollars annually, as well as engine failures on account of flues continually leaking in the weld. Coleman's way is faster and a great deal cheaper.

The flue points used in these demonstrations are steel points, but Mr. Coleman has designed a copper flue point to be welded to locomotive boiler tubes, and has perfected a welding flux that will successfully join copper on steel, iron, cast iron, and will join copper and brass also.

The regulation flue is one-eighth of an inch thick, and for forty years it has been the common shop practice to point or narrow down, or swedge down, the flue one-eighth of an inch at the firebox end. After a copper ferrule has been placed in the tube holes at firebox, the tube end is driven into the firebox sheet, which is usually one-half inch thick. The swedged end of flues is driven so that the end of flue protrudes through the sheet one-fourth of an inch. It is then rolled out, Prossered and beaded over on the firebox side of the sheet.

The merit of the Coleman flue point lies in the increased thickness of the flue point and in the tapering hole, tapered from the firebox side, which is one-eighth of an inch larger on the firebox side than on the water side. When the Coleman flue point is set firmly against the shoulder on the water side of the sheet, and expansion is taking place, the flue is pushing against the shoulder, and not pushing the bead off of the sheet on the firebox side, as is done by the old method. When the tubes are contracting, the flue instead of pulling against the bead and loosening is pulling against the tapered hole in the flue sheet, and not straining the bead on the firebox side.

No one to date had ever thought to make the flue thicker at the end where the intense heat was, and the wear came, and no one had ever thought to taper the hole from the firebox side of the sheet. In order to set tubes in a boiler that would not leak there were two important things to be done, and they were to overcome contraction and expansion and at the same time the flue point had to be made stronger and the flue sheet strengthened. By adding an extra thickness to the flue point and by reducing the hole at the firebox, the flue sheet was

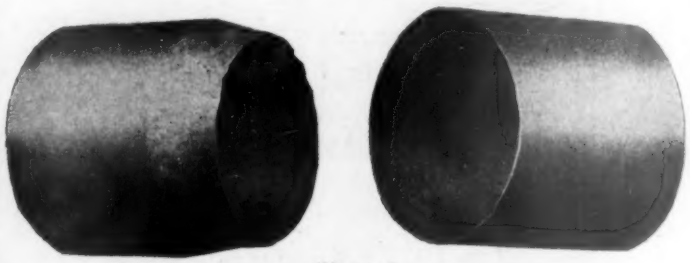


Figure 3.

made stronger. The shoulder on the flue point takes care of the expansion, and the tapered hole through the flue sheet takes care of the contraction, the result being no leaks.

The reducing of the diameter of the flue points at the firebox from two inches, inside measurement, to one and one-half inches, solved two problems in boiler construction and increased boiler efficiency as follows:

First. The thickness of point at the firebox with the tapering hole through the flue sheet of less size than the old style flue required, not only increased the life of the flue sheet, but stopped the leaks.

Second. The decreased diameter of the flue end opening into the larger diameter of the tube improved combustion to such an extent that with tight tubes from 15 to 20 per cent of the fuel bill is saved.

Following is an interesting letter written by Mr. W. F. Charlton—for thirty-five years a boilermaker, and later chief boiler inspector for the S. P., L. A. & S. L. R. R.:

"After a close study of your description and samples of flue points and method of applying to boiler, it is my opinion that you have invented the most practical and economical method of applying tubes to locomotive boilers that I have seen in thirty-five years' experience in constructing and maintenance of steam boilers. I say economical advisedly, because I believe your de-

vice will prevent 90 per cent of the flue leakage on the road that prevails with the standard method of setting locomotive boiler tubes now in common practice. This would be a saving of a vast amount of money, to a railroad company in their fuel bill, since from 10 to 2 per cent more fuel is required in the case of leaky flues to do the same work over the road than would be used with tight tubes. Again, in what is called bad feed water districts, where locomotive boiler tubes run from three to nine months and make from 20,000 to 30,000 miles, I feel confident that your device will at least double the mileage of tubes between shopping for resetting.

"The pre-war total cost per tube for labor, material and charge is about thirty cents for removing, retipping and applying. Or, for an average set of flues, about $100 with our present standard method. (Present prices are about double that sum). Your device would save one or two shoppings a year for flue renewals. Locomotives are worth $25 to $50 per day to the railroad company. They are out of service receiving flue renewals in shop from six to ten days. But the saving that appeals the most to the practical railroad man handling the locomotives is the availability of the engine for service, so to speak. It is such a common experience now for engines to arrive at terminal with some leaky tubes. This engine is needed at once but cannot be sent out because the tubes are leaking. Engines must be killed and tubes expanded and calked, causing some hours delay and expense. Whereas, with your device, the tubes would be tight and engine could be used at once, reducing terminal delays of power wonderfully."

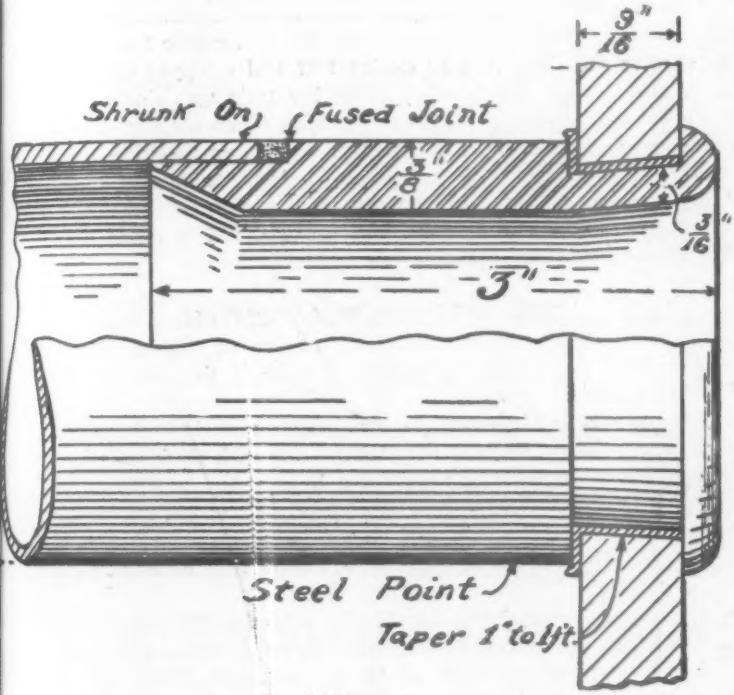


Figure 2.

Arrangements were made to have a thorough test of the merits of the flue and on the Rio Grande Division of the Santa Fe R. R., which, on account of local conditions, was one of the hardest on locomotives in the entire system. The report of the test follows:

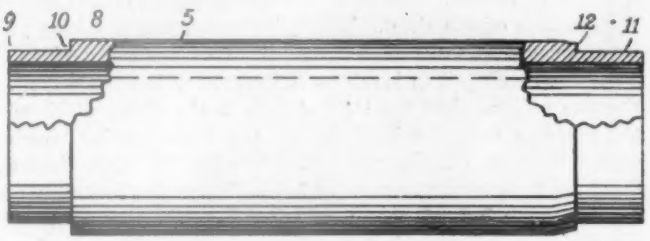
Four engines, all of the same type and class, all superheaters, were selected to make the test.

Engine 1117 was the only one equipped with the Coleman Safe Tube Ends; 1062, 1147 and 1149 had the old style flue ends, the test being for efficiency, mileage, coal saved.

Engine Number	Locomotive Miles	Tons of Freight	Tons of Coal	Tons of Coal per 100 miles
APRIL, 1917				
1062	3,579	67,923	338	8.49
1147	3,492	89,370	408	11.39
1149	3,633	45,380	361	10.33
Average:	3,568	67,557	369	10.07
1117	3,708	76,538	288	7.76
MAY, 1917				
1062	508	6,309	49	9.64
1147	4,242	84,781	356	8.39
1149	4,301	77,105	393	9.13
Average:	3,017	56,065	268	9.05
1117	4,381	111,513	338	7.71
JUNE, 1917				
1062	4,128	51,058	378	9.16
1147	3,132	44,427	305	9.73
1149	2,340	39,034	275	11.75
Average:	3,165	44,506	305	10.21
1117	4,943	81,998	313	6.33

Figure 4.

Following is a detailed description of the method of welding the flue point to the old flue and the method of applying the flue point to the flue sheet.



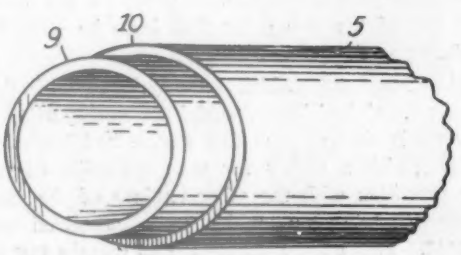


Figure 5.

The end of the flue point that is to be welded to the boiler tube is scarfed ¾ inch and is left one sixty-fourth larger than the inside diameter of the old flue. The flue is then heated until it expands sufficiently to go on the scarfed end of the flue point. An opening of one-eighth inch is left between the end

of the old flue and the scarfed section. When this is cooled the old flue is shrunk on the point very tight. The end of the flue and the scarfed end are fused with a gas weld. When these two points are brought to a welding heat then the operator fills this one-eighth inch opening with a soft steel. This metal cannot run through any waste as it has a solid wall. This solid wall is the result of the old flue being shrunk on the point, so the metal does not run through to the inside of the flue which would make the inside of the flue rough, and cause the flue to become choked. With this weld the inside of the flue is perfectly smooth. This is the easiest and cheapest weld that can be made.

Two sets of these flues have been welded this way for locomotives making 800 and these flues before being put in the boilers were subjected to a cold water test of 400 lbs. pressure on inside of tube and at the point where the weld was made, were struck several times with a hammer to test for a leak, but no leak occurred in any of these flues. Ordinarily with the old style of welding under the same test at least 25 flues would have shown leaks at the weld.

As previously stated, both copper and steel flue points are used. With Coleman's method copper points can be welded on iron flues. While copper flue points cost more than the steel point, the additional service obtained from the copper point will justify the railroad in using it.

In Argentine, English locomotives are being used, having copper flues the full length of the boiler. With the Coleman method of welding, a copper point can be welded on an iron flue, and by so doing 20 flues of the Coleman style could be installed for the cost of installing one of the copper. It is not necessary to use copper for the entire length of the flue, as the leakage is only at the firebox end. The Coleman point remedies this leaking at the end and saves the necessity of using the copper the entire length of the flue. This copper point can be used of different lengths, preferably two inches. It requires about two minutes to make the weld, either with copper or iron points. When the steel point is used, there is an undercut of one-thirty-second of an inch on the end that goes through the flue sheet. This sharp point sinks into the copper gasket. An air ram is set against the front of the flue, and a pressure of 500 lbs. forces the sharp point into the copper on the water side of the firebox end, while it is being expanded with the rolls, and then it is firmly beaded. The hole in the flue sheet is tapered from the fire side of the sheet. When the contraction is taking place as the engine flues cool down, instead of pulling against the head and causing it to break as is the case with the old method, the flue pulls against the tapered hole in the sheet, which takes the pressure from the head against the copper gasket which is placed between the flue point and the flue sheet, producing a tight joint through the tapered hole. When the boiler is fired up the expansion of the flues take place, instead of pushing the sharp shoulder against the flange of the gasket on the inside of the boiler sheet, thus forming a very tight joint.

In the accompanying illustration (Figure 3) the method of scarfing the end of the flue point that is to be welded to the old flue is shown at the point of the arrows.

When engine No. 1117 (which was equipped with the Coleman steel flue points) had been tested for a period of 13 months the official records showed that this engine had hauled 860,659 tons of freight, with a saving for each 100 miles of two tons of coal in competition with the other engines of the same type but with the old style flues, which were compared with the engine No. 1117. This engine during the 13 months test covered 5,393 more miles than its competitors, and hauled 200,502 more tons of freight. At the same time it used 454 tons less of coal, and had accomplished enough more than the others that if 1,500 engines were equipped with the Coleman flues and welded by the Coleman method, they would do the same work as 2,000 engines equipped with the old style of flues, and 48,750 engines would do as much as the 65,000 now in use. At this rate the Santa Fe would save about $8,000,000 a year, and the railroads of the United States would save about $260,000,000 per annum.

Estimating coal at $2.55 a ton (at the time the tests were made) the following saving is seen to have been made by engine 1117 while covering 5,393 more miles than her competitors:

454 tons of coal	$1,157.70
620 tons of coal, amount necessary to haul trains 5,393 miles, 11½ tons per 100 miles	1,581.00
Total	$2,738.70

Furthermore, engine 1117 has hauled 200,502 more tons than her competitors. Considering that in 5,393 miles this engine hauled 100,000 tons, this leaves 100,000 tons advantage. Estimating this as 50 trains requiring 11½ tons of coal to haul each train 100 miles, we find a saving of 575 tons, worth $1,466.25.

Actual saving, as stated	$2,738.70
Estimated saving	1,466.25
Total	$4,204.95

In April, 1917, the first month of this test, engine 1147 out of shop at the same time as engine 1117 and equipped with new flues, old style, failed twice, giving her train up. Engine 1150 failed once, and engine 1126 failed twice, all on account of flues leaking. There were 15 failures in engines on the Rio Grande division on account of leaky flues in April, 1917. But engine 1117, equipped with Coleman flue point and in service thirteen months, and engine 1126, likewise equipped and in service four months, had never had a failure.

THE VILLAGE BLACKSMITH

In a recent editorial, under the caption of "Changes," the *Cleveland Press* thus extinguishes the fire in the forge of the village smith:

"The village blacksmith, 'and a mighty man is he,' was the village tinker. He fixed everything. But with all his mechanical ability he is being pushed out by a new type—blame the gasoline motor. The shop has been turned into a garage. There are a lathe and an oxy-acetylene welding plant. The horses of the plow have been replaced by a tractor that never needs a horseshoe."

Commenting on the *Press* editorial, a blacksmith-welder says: "Perhaps the truth of the matter is that the village blacksmith is not 'passing' so much as he is 'growing.' With 'all his mechanical ability' to 'fix everything' he does not balk at taking on the new things that get out of 'whack,' even to automobiles and tractors; only, being progressive, he uses the tools and processes that enable him to turn out good work in the least time and at the lowest cost. Of course he is an oxy-acetylene welder. And he is a good one too. He knew how to weld before there was an acetylene torch in the world, so why shouldn't he be a good welder with the oxy-acetylene blowpipe? The basis of all good welding is experience in working metals under heat, together with the 'mechanical ability' to handle the work right. The blowpipe is just as much a blacksmith's tool as a sledge or anvil. He takes to it like a tack to a magnet. Don't ever think the blacksmith is being crowded out. He is crowding in. You can bet your Liberty Bonds on that!"

In line with this view, the Oxweld Acetylene Company, of Newark, N. J., and Chicago, reports that the demand for oxy-acetylene equipment in the blacksmith shop is growing daily, and it is now the exception where the progressive blacksmith has not some type of welding torch, a cutting torch, his cylinder of Linde oxygen and the companion Prest-O-Lite acetylene tank. Of all mechanics, blacksmiths are said to be the quickest to become expert in manipulation of the welding and cutting flames, usually requiring but the briefest of preliminary instruction.

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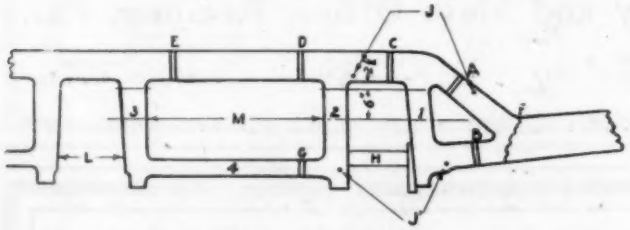
WELDING LOCOMOTIVE FRAMES

By M. C. Whelan, Blacksmith Foreman, St. Louis-San Francisco, Kansas City, Mo.

In thermit welding the practice of heating the lower member when the top is broken is not satisfactory, unless the lower member is kept hot until the top is cold, and in most cases by the time that the black heat contraction is taking place the lower member has been entirely cold for some time. As a result the strain on the weld is tremendous. The method described supersedes the practice of jacking up or distorting the frame to procure expansion and keeps the frame in alignment at all times. The method is not an experiment, but has been adopted and used after a thorough study of the other methods in vogue. The following instructions to be followed in connection with the sketch fully describe the procedure referred to.

When the frame is broken at A, the top and bottom should be trammed at J and J' and expanded by heating the pedestal jaw at I, using bar and wedge H or jack, care being taken that the top and bottom tram marks show the same amount of expansion. After the frame at I is black hot, the bar H, or jack, may be removed, as no pressure remains. After the wax pattern and mold box are applied a fire brick furnace should be constructed so that heat will radiate around the frame jaw at the same point where the heat was applied to expand— namely, I. Two hours and a half after the crucible is tapped, and when contraction is started in the weld, I should again be heated through a hole in the furnace to a good high heat and then all holes in the furnace should be closed. The frame should then be luted with clay to retain



Welding Diagram for Locomotive Frame

the heat and allowed to contract to the original length while cooling at A. The following morning the frame should be heated again at I and at B to a low red heat. This will eliminate any strain which may remain from uneven cooling of A and I.

If this procedure is followed there will be no strain tending to break the frame at or near the part repaired. A glance at a broken frame in the box section will often show the enormous strain left in the frame by the fact that it is $\frac{1}{32}$ in. to $\frac{3}{32}$ in. apart at the break.

When a frame is broken at B it should be heated at the same place as if broken at A—namely, at I. It should be wedged for expansion at B, after which the furnace should be placed at I and heat applied 2½ hours after the weld is made. Heat should again be applied at I and B as a final preventive against strain. This method may be applied at any point on the frame. If the break is at D the frame should be heated for expansion at 2 and wedged at H, using the furnace at 2, and lastly heating at 2 and 4. If at E, it should be handled in the same way by heating at 3, using the wedge H at L, and lastly at 3 and 4.

In welding a heavy frame at D and G recently a great deal of labor was required to strip for room, so that both frames could be welded at the same time in conformity with our practice. The frame was spread at M for the weld at D, after which, by heating at 2 and wedging at G, the weld was made at G by using the furnace at 2 and finally heating at 2 and 4 ($\frac{3}{32}$ in. expansion is enough for heavy frames when using this method, as there is no pressure against the frame until the jaw is hot, after which the frame contracts naturally and uniformly). This procedure will not distort the jaw.

A number of welds have been made at I under the saddle, which is a difficult place and requires at least 4½ hours to heat properly in order to make a successful weld. Care must be taken to have the heating gate so set that the heat will strike directly on the heavier member of the broken part. If the heavier part is hot the heat from that part will heat the lighter one. Expansion at this point is gained by placing a heavy rail across and through the jaws of both frames and a heavy jack placed between the saddle and this support.

When frames are broken at C, expansion is gained in the usual way by the use of bar H, as shown in sketch. Welds at C and F require about $\frac{3}{32}$ in. more expansion than with the expansion system of heating, on account of the pressure on the weld when contraction is taking place after the wedge is out.

If the wax pattern and mold boxes are properly applied the pouring gate made high enough to overcome any back pressure when the metal rises in the mold and the frame heated up to at least 1,100 deg. F. before tapping, no failures will occur where this method is followed. To obtain the temperature required for large breaks, such as 5 in. by 12 in. or over, two heating gates should be used, one on each side if possible, using a double burner preheater. On extra high welds two pouring gates or one sub-gate to assist in carrying the metal should also be used.—*The Railway Mechanical Engineer.*

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CONTENTS

CHAPTER I.—APPARATUS KNOWLEDGE.
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CHAPTER II.—SHOP EQUIPMENT AND INITIAL PROCEDURE.
Preheating Agencies—Welding Table—Location of Welding Outfit—Starting the Welding Outfit—Adjustment of Flame—Principle of Welding—General Welding Knowledge—Welding Rods and Fluxes—Choice of Tip—Expansion and Contraction.

CHAPTER III.—CAST IRON.
Simple Welding—How to Hold the Flame—Hard Cast Iron—Pin Holes and Blow Holes—Lug on Cylinder—Water Outlet—Cylinder Welding—Compression Head—Finishing and Testing—Scored Cylinders—Cylinder Parts—Fly Wheels—Pistons—Crank Cases — Babbitted Bearings — Valve Guides—Preserving Threads—Conclusion of Cast Iron.

CHAPTER IV.—ALUMINUM.
Use of—Welding Knowledge—Puddle System—Flux System—Comparison of Systems—Welding Rod—Preparation of the Weld—Inlet Manifold—Arm of Crank Case—Welding the Arm Without Taking Out the Motor—Break in the Body of Case—Welding Cold —Wrong Method of Setting Up—Lug or Boss Welding—Preheating the Case —Gas Preheating Flame—One Side or Both—Collapse of Weld—Broken Bearings—Direction of Welding—Shrinkage Cracks—Missing Parts—Finishing—Die Moulded Castings—Body—Other Parts.

CHAPTER V.—STEEL.
Welding Knowledge—What the Flame Does to Steel—The Welding Rod—Simple Welding—Position of Flame—Reinforcing the Weld—Frame Welding—Lengthening the Chassis—Tube Housings—Worn Parts—Gear Welding — Case Hardening — Light Metal Welding—Gasoline Tank—Welding Adjacent to Rivets—Shaft Welding—Construction of Parts.

CHAPTER VI.—MALLEABLE IRON, COPPER, BRASS, BRONZE.
How to Detect Malleable Iron—Brazing Malleable Iron—Rear Housing—Reinforcing the Braze—Brazing Tube to Housing—Building Up Worn Parts—Copper—Brass and Bronze—Silver Soldering.

CHAPTER VII.—CARBON BURNING AND OTHER USES OF OXYGEN AND ACETYLENE.
Principle of Carbon Burning—Method of Operation—Lead Burning—Soldering—Case Hardening—Heating Uses.

CHAPTER VIII.—HOW TO FIGURE COST OF WELDING.
Oxygen Consumption—Dissolved Acetylene Consumption—Torch Consumption Test—Acetylene Generator Consumption—Cost Card—Conclusion.

Sent to any address Postpaid on receipt of $1.50 **THE WELDING ENGINEER** 608 So. Dearborn St. CHICAGO ILLINOIS

pressure cylinder are shown in the accompanying photograph. The crack in the upper left-hand corner of the picture extended back to and completely around the inlet valve port. The crack at the bottom of this cylinder extended no further than can be seen in the photograph.

Low Pressure Cylinder After Welding.

As the casting was preheated the men shown in the photograph could not, of course, have worked from the position shown. They are so shown in the picture to give an idea of the size of the cylinder bore. The high-pressure cylinder was also badly broken.

Inasmuch as the engine was of an obsolete type and occupied excessive space in the engine room, upon a report of the accident the owners decided they would replace it by a steam turbine. However, when the matter was taken up with the manufacturers it was found that no delivery date could be promised within ten months. This delay was, of course, out of the question, no outside power being available.

Then an effort was made to obtain the old patterns from the firm that had originally made the cylinder. Here again the flour mill owners met with disappointment. The original patterns had been destroyed, and new castings would have cost approximately $9,000 exclusive of freight charges and cost of installation.

The location of the engine room and adjacent machinery was such that the cost of installation would have reached a high figure and would have brought the entire bill, exclusive of the costs of delay, up to approximately $15,000.

Having failed to obtain a steam turbine and not caring to spend such a large amount for new castings, the owners at this point took the matter up with the Imperial Welding Co. and asked if the cylinders could be satisfactorily welded. Upon being assured that they could, the job of reclamation was given to the Imperial shop and men were set to work at once to repair the damage.

Four men were employed to do the work, the actual time to weld the casting being forty-eight hours. The total amount of time to chip out the castings and otherwise prepare for welding, as well as to actually make the welds, was three weeks. The operation presented no unusual difficulties, preheating being done one section at a time.

The material used for the work consisted of the following: Thirty cylinders of oxygen; 26 cylinders of acetylene, 4 pounds of flux; 407 pounds of cast iron rod; 4,150 pounds of charcoal; 32 carbon blocks, ½x½x12 inches. An Airco "A" welding torch was used to do the work.

The actual cost of welding these cylinders was $1,572.22. Not taking into consideration the delay that would have resulted if new castings had been made, the owners were able to save over $13,000 by taking advantage of the oxy-acetylene process.

THE OXY-ACETYLENE INDUSTRY IN CUBA

The Cuban Air Products Corporation have erected and now have in operation an oxygen factory, located at Batista Station Luyano, a suburb of Havana. The plant is built under the Claude patents. The erection of this plant means a great boost to the oxy-acetylene industry in Cuba, which heretofore has been dependent on the importation of oxygen from the U. S. which was very unsatisfactory.

Oxygen Plant, Cuban Air Products Corporation, Havana, Cuba.

A few concerns about the island have had in use small electrolytic plants and occassionally one finds the installation of a small plant for making oxygen by the chemical process but these are now being abandoned inasmuch as the consumers

Fyber-Weld GOGGLES for Welders

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Frame is made entirely of vulcanized fibre, and in addition to being light in weight is a non-conductor of heat and electricity, is non-inflammable and infusible, is not affected by moisture or perspiration and is easily sterilized and kept sanitary. Has flexible leather center, ventilated side pieces and adjustable elastic headband.

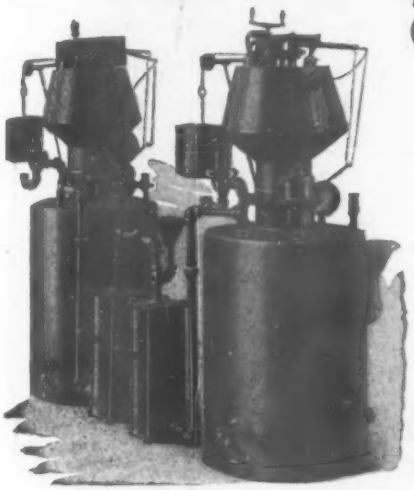
Prices as follows:

No. 510, fitted Essentialite lenses, No. 4 shade, for cutting and cover glasses.....$3.00 pair
No. 510, fitted Essentialite lenses, No. 6 shade, for welding and cover glasses.....$3.00 pair
No. 510, fitted with amber, smoked green or deep blue, cobco blue and cover glasses.$2.50 pair
Extra cover glasses in clear or amber tint..... .20 pair

"ESSENTIALITE" LENSES

To those of our patrons who are not thoroughly conversant with the real qualities and benefits of "Essentialite" lenses, we take pleasure in furnishing the following information. In placing the "Essentialite" before the trade, we have, after years of experimenting and research, succeeded in discovering the means of protecting the delicate organism of sight against the destructive Ultra Violet rays. We have demonstrated conclusively that with these lenses we vanquish the so-called "fatigue-weariness" and headaches caused by Ultra Violet and Infra Red rays.

Manufactured By **CHICAGO EYE-SHIELD CO., 2300 Warren Ave., Chicago, Ill.**



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Superior Oxy - Acetylene Machine Co.

Our New England States Representative,
R. I. WELDING CO., Providence, R. I.

Hamilton, Ohio

know that at last they can depend upon an adequate oxygen supply manufactured in Havana.

The larger users of oxygen in Cuba are the railroads and sugar mills, the largest R. R. shops being located at Havana and Sagua la Grande. Most of the sugar companies operate their own railway systems, varying in size from a few miles to several hundred miles of track and a corresponding number of locomotives and rolling stock. Other industries including foundries, boiler shops and various iron trades use considerable oxygen, one of the most important being the Havana Marine Co., of Havana, who specialize in ship repair. There are also repair shops specializing on oxy-acetylene welding or "Soldadura Antogena" as it is termed in Spanish. Some of the repair shops are operated by native mechanics, and some by foreigners, either from the U. S. or British possessions.

One of the most up to date individual welding shops is operated by a native who saw his first torch while working with a crew in connection with raising the battleship Maine in Havana harbor a few years ago. Realizing his opportunity he bought an outfit and learned the use of it by hard work, and now has a good business in the town of Cardenas.

The most up to date shop in Havana using welding on a large scale is that in the railroad shops at Cienega. Under the supervision of Mr. Owen native operators have been developed in both oxy-acetylene and electric welding and the class of work turned out is a credit to the welding trade.

An installation worthy of mention is one recently made at the Luyano car shops of the Havana Central Railway. Here, worn out and wrecked cars have been accumulating faster than they could take care of them with a gang of men using rivet breakers. A demonstration on cutting up a wrecked steel gondola has resulted in an installation of six cutting units, and operators trained, who have started in to clear the yards of nearly three hundred of these cars besides other miscellaneous wreckage which has accumulated.

Mr. W. K. Dowe, formerly manager of the Air Reduction Sales Co. of Detroit, is manager of the Cuban Air Prod. Corp., with offices at Obispo-7, Havana.

BROTHERHOOD OF WELDERS

Welders of the great state of Illinois. Wake up! Get busy! Don't let the other states beat us in membership. We now have members from 23 states, and while our own state of Illinois is still in the lead, we must hustle or some of the other states will put it over us in membership.

We don't want slackers, but real live wire members, and they are coming in from Maine to California, and from Florida to the Canal Zone. Any welder, gas, or electric, who has served one year or more at the trade is eligible to membership, and so is the employer of welders, if he works with his men at the trade. Our $5.00 entrance fee is still open to non-union welders, with dues of $1.00 per month, and to A. F. of L. boys no entrance fee is required. Simply dues of 50 cents per month and 50 cents for emblem buttons to all members, until further notice.

What the employers want is better welders, and, remember, boys, you cannot learn this trade in one year, or five. The writer has had fourteen years' training in this art and profession, and still don't know it all. So get busy. Don't wait for the other fellow to do it all. Send in your application and do it today. In union there is strength, the same as in a good weld. We want every welder and cutter, gas and electric, in the state of Illinois and the United States of America.

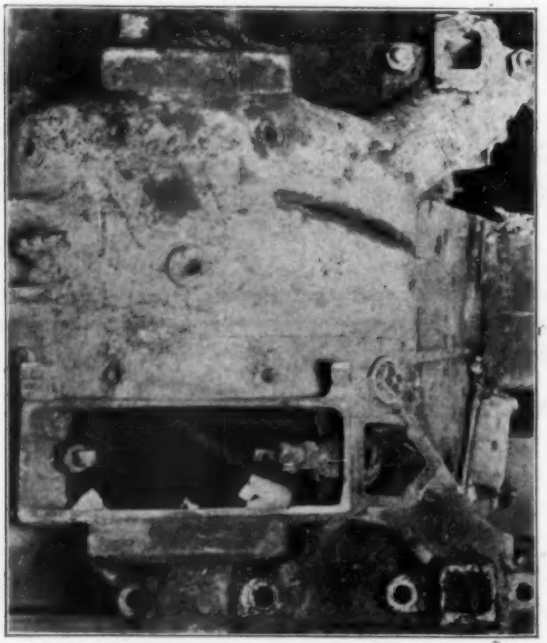
Watch the Welding Engineer as to our progress and you will be kept posted on the Brotherhood of Gas and Electric Welders and Operators of America Incorporated.

Chicago Local Lodge No. 391.

C. H. Knight,
Recording Secretary and National Organizer,
521 W. Jackson Blvd., Chicago, Ill.

ARC WELDING FOR FOUNDRIES

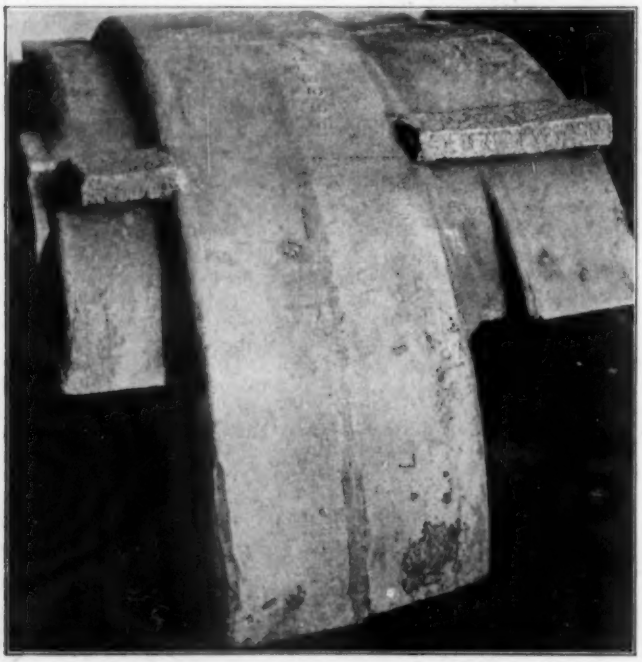
Electric arc welding has proved itself a valuable aid to work of the character done in foundries, both in connection with the castings, and in making repairs to, or building blast furnaces. It does work that formerly could hardly be done



Cast Iron Motor Case Reclaimed by G. E. Constant Energy Welding Machine.

at all, without considerable expense due to shut-downs, labor and material, and does it quickly with thoroughly reliable results.

Parts of blast furnaces that formerly required riveting, with consequent machine work, and other preparations, such as water-jacket doors, and frames can be readily welded by



Feet Built on Steel Casting by Arc Welding.

this process with a resultant joint that is just as strong, mechanically as the riveted joint. Other work that can be very expeditiously done is the welding of light gauge metal piping of any dimension, and butt welds of plates, etc.

The performance of arc welding from a reclamation standpoint is nearly, if not quite as important as it is from a constructive one.

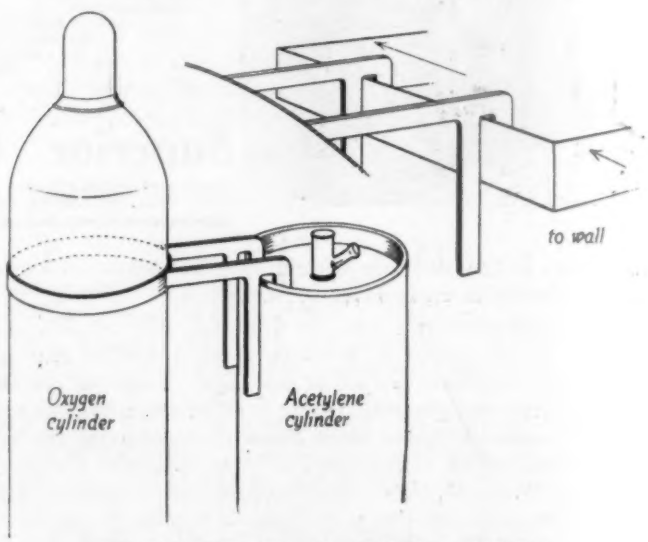
It is used to a considerable degree to fill blowholes, cracks, and other flaws in finished castings, the metal deposited being just as good, mechanically and physically as the original metal of the casting. Material that formerly had to be remelted and poured over can be saved in this way, with a resultant considerable saving in operating costs.

The electric arc can be used for work that would cause considerable trouble due to its inaccessibility, to any other form of welding, or riveting, since the heat is absolutely confined to the arc itself, and the area immediately has to be made for expansion and subsequent contraction of the parts being welded.

With the development by the General Electric Company, of an automatic arc welding head, which is capable of doing all sorts of work, but is principally valuable for work requiring a large amount of metal deposition, the speed of welding, and the uniformity and quality of the finished weld has been improved, while the time required, and labor expense has been correspondingly reduced.

SUPPORT FOR CYLINDERS.

Editor: This sketch shows a little article that I have found very useful, especially when the welder has no truck



This Device Will Prevent Accidents to Cylinders

or other means of supporting cylinders while they are standing up. The oxygen cylinder is easily pushed over, still it must be kept in an upright position where it will occupy less floor space and avoid damage to regulator and gauges. The diagram is self-explanatory, and I think some welders will find the little device, which can be made in a few minutes from scrap, useful in cases where the welding outfit is to be stationed at one place. When using this support, I adjust it before attaching the oxygen regulator. In the drawing it is shown resting on the acetylene cylinder. If a plate can be fastened to the wall to receive it, thus giving absolutely rigid support, so much the better.

B. TAYLOR PIPER.

For Sale—One large D. B. welding torch; one small D. B. welding torch; two oxygen regulators; two acetylene regulators. Will take $150.00 for entire lot. Torches and regulators are in good working condition. Will sell individually or collectively. J. Hahn, 223 Meeting St., Charleston, S. C. tf

Scored Cylinders

and cracked water jackets successfully repaired. Our factory nearest you will make these repairs on a 24-hour service basis.

Regrinding of cylinders that have been scored by wrist pins or through other causes is unnecessary. The Lawrence Patent Process fuses a silver-nickel alloy into the defects, making a quick, clean, permanent job without altering the bore of the cylinder. Same pistons and rings fit.

Cracked Water Jackets Are Also Made Permanently Good Thru This Same Process

A list of our factories and licensees is given below. There is one near you. Send your scored cylinders and cracked water jackets to the nearest plant. There we will insure you quick service and perfect results. Aside from the liberal arrangements we make with you, the money saving service you render your customers will help make you known as a concern that looks after their interests—and this is a business asset in itself.

We Guarantee All of Our Work. **PLANTS** **Write For Full Information.**

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Milwaukee—18 Martin St.
Minneapolis—14 N. 9th St.
Newark—292 Halsey St.
New York City—355 W. 57th St.
Philadelphia—1601 Summer St.
Pittsburgh—5102 Baum Blvd.
San Francisco—116 Hyde St.

LICENSEES

LICENSEES

Aberdeen, S. D.—Detwiler Auto Electric Service Co., 112 3rd Ave., S. W.
Aberdeen, Wash.—Grays Harbor Welding Co., 417 South F St.
Alamosa, Colo.—Sumner, Ginder & Teal.
Brooklyn, N. Y.—Manufacturers Welding Co., 154 Berriman St.
Brookline, Mass.—Back Bay Welding Co., 17 Brookline Ave.
Bloomington, Ill.—Keiser Vanleer Co., 505 N. Market St.
Burlington, Iowa—The Paul Gross Machine Shop, 212 Washington St.
Baltimore, Md.—Reus Brothers Co., 150 W. Mt. Royal Ave.
Bay City, Mich.—L. D. Sheets, 506 E. John St.
Birmingham, Ala.—W. T. Sanborn & Co., 1010 N. 19th St.
Bridgeport, Conn.—United Welding & Repair Co., 172 Elm St.
Bronx, N. Y.—Victor Iron Works, Inc., 1106 Brook Ave.
Cedar Rapids, Iowa—Otto J. Jirsa, 1328 L St.
Corpus Christi, Texas—Corpus Christi Boiler & Machine Wks., Cor. Laguna & Chaparral Sts.
Columbus, Ohio—Central Ohio Welding Co., 200 East Lynn St.
Denver, Colo.—Blanchette Welding Co., 149 S. Broadway.
Dallas, Texas—Lawrence Process Co., 3001 Commerce St.
Des Moines, Iowa—Bernhard & Turner Auto Co., 506 W. 7th St.
Davenport, Iowa—Rival Machine Co., 316 E. 3rd St.
Erie, Pa.—Lake Erie Welding & Spring Co., 3383 W. 12th St.
Eustis, Fla.—M. Hopson.
Evansville, Ind.—The Lindenschmidt Co., Ingel St., bet. 1st & 2nd Aves.
Flandreau, S. D.—Amdahl Bros. Co.
Fort Wayne, Ind.—Motor Truck Sales Co.
Fargo, N. D.—Craig Brothers.
Grand Rapids, Mich.—Ox Welding Co., 538 S. Division St., cor Buckley.
Galesburg, Ill.—P. & M. Electric Co., 280 S. Seminary St.
Houston, Texas—United Motors Co., 614 Louisiana St.
Hartford, Wis.—Kissel Motor Car Co.
Harrisburg, Pa.—Harrisburg Welding & Brazing Company, 94 S. Cameron St.
Hartford, Conn.—Charter Oak Machine Co., 438 Asylum St.
Jacksonville, Fla.—Wm. Mock, Jr.
Kansas City, Mo.—General Auto Parts Co., 1621 Grand Ave.
Louisville, Ky.—Southern Motor Co., 615 S. 3rd St.
Lima, Ohio—Buckeye Welding & Repair Shop, 133 Water St.
Lincoln, Nebr.—Lincoln Motor Car Co., cor. Q. & 12th Sts.
Modesto, Calif.—Modesto Motor Co., 9th & L Sts.
Marysville, Calif.—Yuba Machine Works, 216 Third St.
Montrose, Colo.—Hartman Bros. Co.
Memphis, Tenn.—J. B. Cook Auto & Machine Co., 247 Poplar Ave.
Marion, Ohio—R. G. Wolfel Welding Co., 206 W. Church St.
New York City—Goodwin Welding Co.
New Haven, Conn.—New Haven Welding Co., 763 State St.
New Orleans, La.—Scored Cylinder Repair Works, 724 Julia St.
Portland, Me.—Portland Garage Co., 49 Cross St.
Pueblo, Colo.—Pueblo Carriage Co., 4th & Court Sts.
Pensacola, Fla.—East Hill Garage, 1501 E. Blunnt St.
Pontiac, Mich.—Autogenous Welding Works, 21 E. Water St.
Portland, Oregon—Oregon Auto Repair, Inc., 16th & Glisan Sts.
Richmond, Va.—F. D. Schluter Auto & Welding Co., 1009 Broad St., W.
Reno, Nev.—Central Auto & Machine Works, cor. 5th & Sierra Sts.
Rochester, N. Y.—General Welding Works, 87 Cortland St.
Raleigh, N. C.—Republic Service Co., 108 S. Blount St.
Sacramento, Calif.—W. G. Hansen Machine Works, 1316 U St.
Seattle, Wash.—Motor Parts Co., 815 E. Pike St.
St. Louis, Mo.—Scored Cylinder Repair Works, 325 N. Jefferson Ave.
Saginaw, Mich.—J. & M. Welding & Repair Co., 317 N. Water St.
San Diego, Calif.—Coburn Machine Co., cor. 2nd & G Sts.
Schenectady, N. Y.—Franken Oxy-Acetylene Welding Co., 722 Broadway.
San Jose, Calif.—Auto Machine Co., 536 W. Santa Clara St.
Soledad, Calif.—Johnson's Garage.
Salt Lake City, Utah—Karl Winter, 719 S. State St.
San Antonio, Texas—General Welding Co., 105 Villita St.
Springfield, Mass.—Hoag Welding Co., 31 East Court St.
Springfield, Ill.—Romie Fields, Rear 317 S. 3rd St.
Sawyer, Wis.—F. J. Pies & Co.
Sioux Falls, S. D.—Schmidt & Son.
Sioux City, Iowa—W. A. Carlson, 1110 Fifth St.
Scranton, Pa.—Scranton Welding Co., 321 Washington Ave.
Spokane, Wash.—Broadway Welding Shop, 1017 W. Broadway.
St. Paul, Minn.—St. Paul Welding & Mfg. Co., 173 West 3rd St.
Tacoma, Wash.—Lampson Welding Works.
Tampa, Fla.—R. G. Wood, 1813 Nebraska Ave.
Troy, N. Y.—Reliable Auto Repair Shop, 233 River St.
Washington, D. C.—Day Welding Co., 43 Sumner Court, N. W.
Worcester, Mass.—Central Autogenous Welding Co., 98 Union St.
Winchester, Va.—Valley Radiator & Welding Co.
Wichita Falls, Texas.—McFall Brothers.
Warren, Ohio—Cooper's Storage Battery Service Co., 102 W. Market St.
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Montreal—Pyke Motor & Yacht Co., 374 Notre Dame St.
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We have a large quantity of brand new welding and cutting hose. Will sell for less than the factory charges for it. This hose was in a warehouse in which there was a fire, and we bought it from the insurance companies. It is guaranteed absolutely perfect and brand new.

The No. 1 copper woven hose is discolored, but is absolutely perfect. All rubber hose is perfect in appearance as well as in quality.

Sizes in stock are: ¼-inch I. D. copper woven, ¼-inch I. D. 7 ply red, ⅜-inch I. D. 7 ply black, ⅜-inch I. D. 2 ply moulded corrugated red, ⅜-inch I. D. 2 ply moulded corrugated black. Dealers, write us for samples and quantity prices. Users, stock up on this hose, as it is a bargain. Address No. 20, care *The Welding Engineer*.

Increase your earning power by making your own **fluxes.** Think of the cash you can save. Write today for prices on **formulas.** American Flux Co., Box 153, Madison Square Station, New York City.

ELECTRIC WELDING EQUIPMENT FOR SALE

Lincoln Portable Gasoline Driven Electric Welding Outfit, connected with Ingersoll-Rand Pulley Driven Air Compressor, mounted on a 5-ton truck, enclosed in Van Body, with hose and cable. All in good condition. Address, Bournonville Welding Co., 241 W. 64th St., New York, N. Y. 1t-Oct.

For Sale—First class, established acetylene welding shop; good business, good locality, two torch plant electric equipment. Address 31, care The Welding Engineer. 1t-Oct.

For Sale—Oxweld 50-lb. Generator, only used one month; complete Portable Outfit with 3 line regulators; 1300 lbs. carbide; all f. o. b. Sarina or Port Huron, Mich., $500.00 cash. Also two welding outfits complete with 200 ft. hose, $250.00. S. J. Howe, Port Huron, Mich. 1t-Oct.

Wanted—First class acetylene welder, electric also preferred. Highest wages, steady work year around. Must be fast. Shop work. Address 32, care The Welding Engineer.

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Commencing November 15th, we will be able to employ about 50 Electric Welders who have had at least two years' experience with direct-current machines on steel plate work. Write or apply at

GENERAL BOILERS COMPANY,
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Wanted—Really good acetylene welders on general machine and automobile repair work (except aluminum). Steady job; wages 10, ten hours. Board, $2. Brown Welding Co., Ranger and Breckenridge, Texas. 2t-Oct.-Nov.

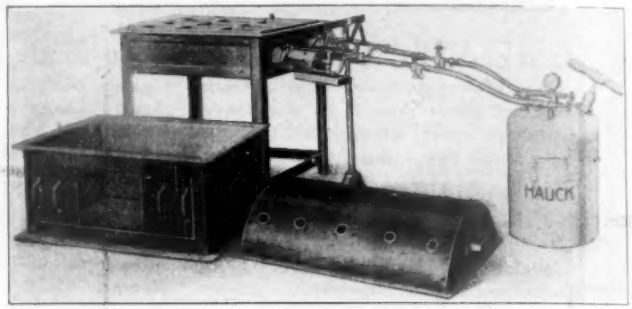
For Sale—Absolutely new, two Type "H" welding outfits, complete; two Type "K" welding outfits, complete. Prestolite make. No reasonable offer rejected. P. H. Shepp, 90 West Street, New York City. 1t-Oct.

A NEW PREHEATING FURNACE

A remarkable practical and satisfactory furnace for preheating is the one shown in the accompanying illustration. It consists of a deep box or oven, with detachable cover, mounted on a preheating table. The box is large enough to accommodate a block of six cylinders and other small parts at the same time. It is equipped with three sliding doors, enabling the operator to watch the work and see that it is not overheated.

The inside of the box is lined with asbestos, which retains the heat, and the oven can be used for reheating after welding. The burners can then be turned off and the castings allowed to cool gradually.

By removing the box and cover, the furnace is converted into a preheating table. The combustion chambers through which the flames of the kerosene preheating burners travel are lined with a patented type of refractory brick, which breaks the flame up into a number of small, soft, flames.



The New Preheater.

The welder can slide the doors open and work, piece after piece, or, he can use a small welding table with fire-brick top—take out one job, weld it, replace it for reheating and and then take another. He can take out a job, weld it, and put a new job in its place to be preheated. Thus continually rotating the work. After all the parts are welded, they are returned to the furnace and gradually allowed to cool.

The burners shown are the so-called hand pump type vaporizing kerosene oil as fuel. The manufacturer, the Hauck Manufacturing Company of Brooklyn state that this furnace is used in their welding department and has proven to be an economical, and indispensable piece of equipment.

NOTICE

Welders of America Gas & Electric, if you want better wages and working conditions, wake up and join Chicago Local Lodge No. 301, Brotherhood of Gas & Electric Welders of America. Address C. H. Knight, Rec-Secy., and National Organizer, 521 W. Jackson Blvd., Chicago, Ill.

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OXY-ACETYLENE
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Every user of the oxy-acetylene process should make

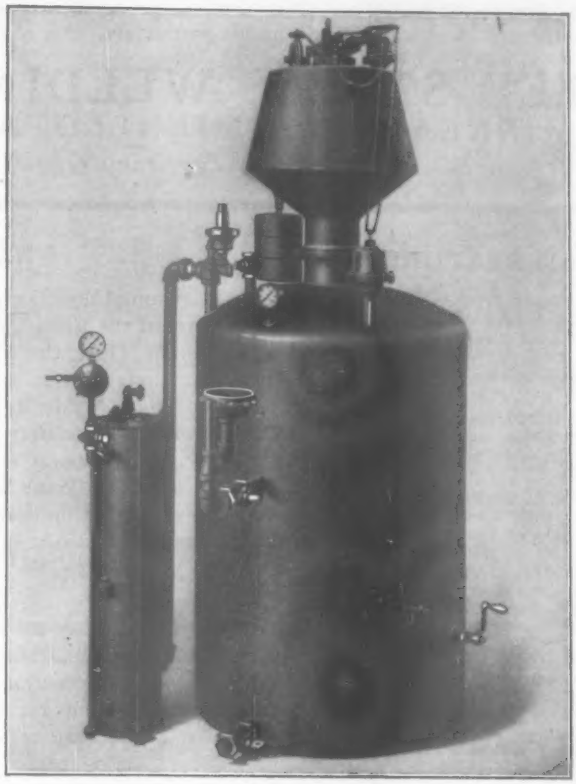
Our Kentucky Acetylene Generator

Costs less than others.

Is of perfect mechanical construction.

Provided with the necessary devices to render its operation absolutely safe.

Can be furnished in double units to operate singly or jointly.



Enables your manufacture of acetylene at about 1¼c per cubic foot.

Insures a supply of the purest gas always.

Eliminates the most disagreeable feature of the oxy-acetylene industry; the investment in and handling of acetylene cylinders to be refilled.

No Fluctuation of Pressures
No Danger from Flashbacks

Remove the uncertainty from your welding and cutting activities.
Increase your profits and efficiency.

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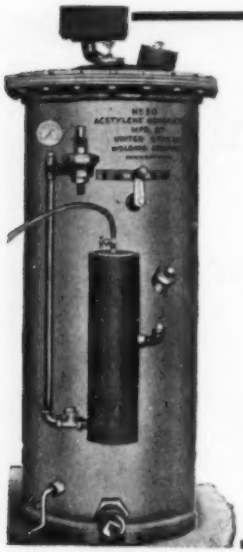

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CURRENT WELDING LITERATURE.

ARC WELDING PROCEDURE, by Ethan Viall.—When preheating may be useful. Effect of varying length of arc. Manipulation of arc and filling sequence. Use of alternating current in arc welding. Typical examples and suggestions for design. Detailed discussion of the strength factor.—The American Machinist, Oct. 7.

WHERE SHALL I PREHEAT? by David Baxter.—A series of examples of fractures occurring in wheels, with instructions for position and method of preheating in each case.—Acetylene Journal, September.

THE ACETYLENE WELDER, by Eli A. Berkley.—A grist of practical ideas and instructions on the subject of oxy-acetylene welding. Special treatment for the repair of Ford crank cases.—Horseshoers' Journal, September.

ARC WELDING EQUIPMENT, by Ethan Viall.—Detail of necessary units for both carbon and metallic electrode processes. Chemical composition of electrodes and its importance in the work. Discussion of proper current values.—American Machinist, Sept. 16.

OXY-ACETYLENE, THE ANTITHESIS OF THE SCRAP-HEAP, by F. A. McLean.—Some cases where resourceful plant executives, confroneed with shortage of labor and raw material have enlisted the services of the modern acetylene welding outfit and put much of their old equipment into service once more with much profit.—The Canadian Welding Journal, September.

THE USE AND ABUSE OF ARC WELDING EQUIPMENT, by H. L. Unland.—A digest of precautions to be observed in electric arc welding, in order to avoid accidents and insure sound welds. Tables of amperage, speed, and electrode diameters for various classes of work.—The Canadian Welding Journal, September.

DIFFERENT MAKES OF ARC WELDING SETS, by Ethan Viall.—Illustrations and descriptions of arc welding sets made by General Electric Company, Westinghouse Electric Company, Lincoln Electric Company, Electric Arc Cutting and Welding Company, Gibb Instrument Company, The Arcwell Corporation, Wilson Welder and Metals Co., The U. S. Light and Heat Corporation.—The American Machinist, Sept. 23.

REPAIRING SCORED CYLINDERS WITH OXY-ACETYLENE FLAME, by David A. Baxter.—For this work a short tipped torch, a small filler rod, and a strictly neutral flame must be used. Preheating should be slow and even. The entire casting should be covered with asbestos paper when finished to provide for slow cooling.—Auto and Tractor Shop, September.

SETTING UP A PORTABLE WELDING EQUIPMENT.—An illustrated article on the A B C of setting up a portable outfit. The pictures show in detail the approved practise of connecting pressure regulators, hose, torch, and lighting up preparatory to welding.—Autogenous Welding, October.

SIDE, OVERHEAD AND PRESSURE WELDING, by W. B. Perdue.—Discussion of side and overhead welds. Illustrations of methods of preparing parts for making a variety of welds in pressure tanks.—Acetylene Journal, October.

HEALTH HINTS FOR WELDERS, by David Baxter.—A few helpful suggestions with regard to bettering the working conditions of the welder.—Acetylene Journal, October.

NEWS ITEMS

At the annual meeting of the American Foundrymen's Association and the Foundry and Machine Tool Exhibition, held at Columbus, Ohio, the week beginning October 4th, the following manufacturers of welding equipment and supplies were represented: Air Reduction Sales Co.; Bastian-Blessing Co.; Cleveland Flux Co.; Davis-Bournonville Co.; Geist Mfg. Co.; General Electric Co.; F. A. Hardy & Co.; Hauck Mfg. Co.; Macleod Co.; Mahr Mfg. Co.; Metal & Thermit Corporation; Alexander Milburn Co.; Oxweld Acetylene Co.; Torchweld Equipment Co.; Westinghouse Electric & Mfg. Co.; F. H. Wheeler Mfg. Co.

A new bulletin has recently been prepared for the trade by the Perfecweld Apparatus Co. The bulletin sets forth the principles of construction and operation of that company's line of welding and cutting torches, and carries a complete price list of the various styles.

Mr. C. M. George, formerly Pacific Coast agent for the Davis-Bournonville Co., has opened an office in the American National Bank Building, San Francisco, to represent a line of oxy-acetylene equipment and supplies.

The Westinghouse Electric & Manufacturing Co., East Pittsburgh, has issued leaflet No. 3461 which describes and illustrates its automatic current regulator for electric arc furnaces with movable electrodes. Schematic wring diagrams and photographs of detailed parts of this apparatus are produced.

Owing to the need of larger office space and convenient store room facilities, C. J. Nyquist & Co., Cleveland, Ohio, have removed from their former location at 985 The Arcade to 1046 St. Clair Avenue.

A two story addition to its power plant, 60x120 ft., will soon be started by the William Cramp & Sons Ship & Engine Building Co.

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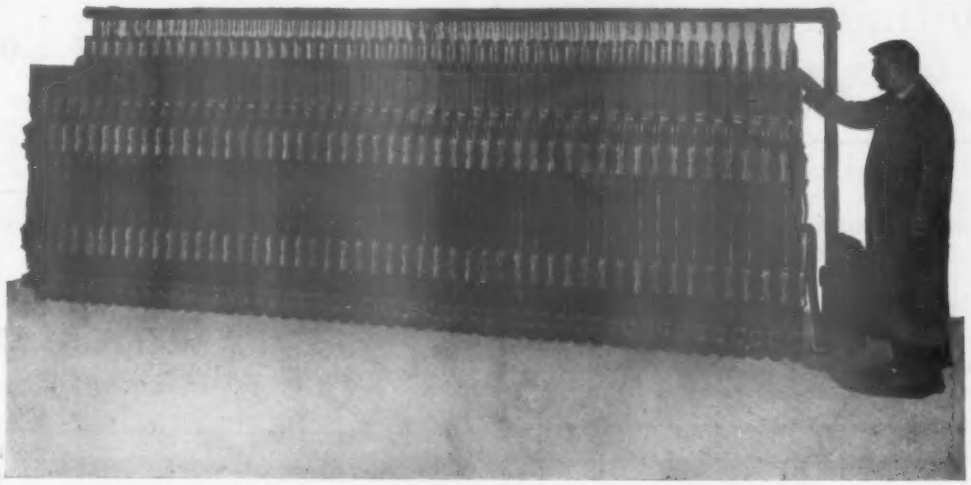

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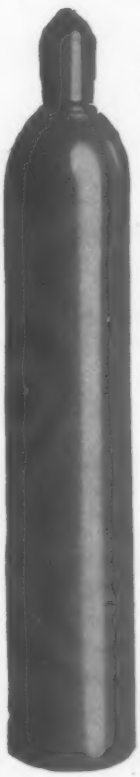

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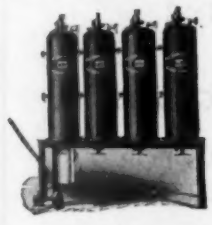

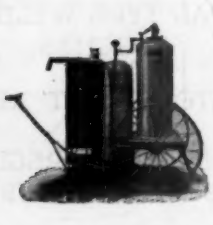

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